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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....225, 239
The Transportation and Erection of a Plate-Girder Highway Bridge (illustrated) 226
Recent Designs in Locomotive Turntables (Concluded, with two-page engraving)..... 228
Engineering Compensation 229
The Calhoun Excavating and Conveying Machine (illustrated) 230
Compressed Air for Blowing Fog Signals 231
Comparison of Formulas for Radiation of Heat (illustrated) 236
An Experimental Electric Railway 236
Civil Service Examinations for Engineering Positions in Brooklyn 237
The Olin Gas and Gasoline Engine (illustrated)..... 237
Natural Distortion of Rock in Place on the Chicago Drainage Canal 238
Book Reviews 240
EDITORIAL NOTES 232
A Novel Method of Moving and Erecting a Plate-Girder Bridge—Recent Progress in Locomotive Turntable Construction—A Proposed Sewer System Franchise at Mobile, Ala.—Accident in the Omaha Street Railway Power House—Correction.
EDITORIAL:
Present Tendencies in Water-Works Practice..... 232
LETTERS TO THE EDITOR 233
A Bridge Wreck from an Unusual Cause—Telephoning to a Diver—Concerning Disagreeable Effect on Railway Curves—Water Power Development at St. Mary's Falls; Most Efficient Slope for Canal—More Engineering Curiosities—Transition Curves.

SAN PEDRO, Cal., was recommended, on March 1, 1897, as a site for harbor improvement by the government in preference to Santa Monica Bay, also named in the River and Harbor bill of June 8, 1896. In accordance with the provisions of this bill, President Cleveland appointed Admiral J. G. Walker, U. S. N.; A. F. Rogers, of the Coast and Geodetic Survey, and Prof. Wm. H. Burr and George S. Morison, both Members of the American Society of Civil Engineers, a commission to decide the final location of a deep water harbor in Southern California. Their report has now been published, with the above result. The general scheme includes a breakwater enclosing an outer harbor, and two lines of jetty construction leading to an inner harbor fronting on the town of San Pedro and the Southern Pacific Ry. The estimated cost of the breakwater to be built is $2,901,787, and the area protected by it is 615 acres, measured between deep water and the 4-fathom line.

FIVE OF THE NEW NORTH RIVER PIERS, in New York, have been rented to the White Star, Cunard and Wilson steamship lines at the following prices: The White Star Co. is to pay $84,375 per annum each for Piers 1 and 2 for ten years, $88,593 per annum for the second term of ten years and $93,999 for the third term of ten years. Each pier is 125 ft. wide and 697 ft. long. The Cunard Company rents the fourth pier, 682 ft. long by 100 ft. wide, for $76,239, $80,051 and $84,854 per annum for similar terms of ten years. The same company will also have the fifth pier, 670 × 70 ft., for $40,842, $42,884 and $45,457 per annum for the terms of ten years. The Cunard and the Wilson Companies agreed to the terms named under protest, but have instructed their lawyers to make efforts to secure a reduction, on the grounds that the rate of rental should be fixed upon superficial area rather than upon the pier length.

MEXICAN PUBLIC IMPROVEMENTS form the subject of a large part of the message of President Diaz, just submitted to the Mexican Congress. Work has been commenced on the sewerage of the City of Mexico, under Roberto Gayal, M. Am. Soc. C. E., City Engineer and member of Board of Health, and the pumping plant for flushing the sewers is to be shortly installed. Since President Diaz's last message, in September, 1896, about 148 miles of railway have been accepted as complete, and 154 miles have been built, but not yet officially accepted, and 75 miles more have been graded ready for the rails. Among other lines, the Mexican Central Ry. contributed 71 miles to this construction, 55 miles of this being a branch from Guadalajara to Ameca. The International Ry. has graded 42 miles between Reata and Monterey; the Corralitos Ry., from Ciudad Juarez, has 105 miles of track laid and it is graded for 135 miles; the Maravatio & Cuernavaca Ry. has graded 51 miles; and several other roads have made notable progress. At the port of Vera Crus, the rockwork on the northwest breakwater is finished, and the southwest breakwater is built out 640 m., and 800,000 cu. m. have been dredged from the harbor. At the port of Tampico a wharf 750 m. long has been built, and the new custom house is commenced.

THE SECOND EXPERT COMMISSION on the new Cincinnati water-works has been selected, as follows: Mr. Henry Flod, of the Mississippi River Commission; Chas. Hermany, Engineer and Superintendent of the Louisville Water-Works; M. L. Holman, Water Commissioner of St. Louis; F. P. Stearns, Chief Engineer of the Metropolitan Water Board, Boston; and Saml. Felton, of Cincinnati, at present receiver of the Cincinnati, New Orleans & Texas Pacific R. R. This commission will report on the plans submitted a year ago (see Engineering News, March 26, 1896) by Messrs. Jno. W. Hill, S. Whinery and G. H. Benzenberg. The permanent local commission includes among its members Mr. August Herrmann, President of the Board of Administration, and Dr. T. W. Graydon.

THE PROPOSED NEW WATER-SUPPLY WORKS for Seattle are likely to be put under construction very soon, the Board of Works having made a report to the city council in which it recommends that the call for bids be issued by June 1 and the contract awarded by July 1. The supply will be by gravity from Cedar River. The board recommends that Mr. A. L. Adams, M. Am. Soc. C. E., of San Francisco, be employed as assistant to the City Engineer, Mr. R. H. Thompson.

BIDS FOR A NEW WATER SUPPLY FOR HOBOKEN, N. J., are to be received until April 30 by the Board of Water Commissioners of that city. The city owns a distribution system, which at present is supplied by the Hackensack Water Co. Bids are asked for a supply for 15, 20 and 25 years, and bidders may state the price at which they will sell the city the supply works and water rights at the end of 5, 10, 15 or 20 years. Mr. Henry Lohmann, Jr., is Water Register.

THE MOST SERIOUS RAILWAY ACCIDENT of the week took place on the Southern Ry. at Harrisburg, N. C., 13 miles north of Charlotte, on April 11. The northbound Florida special, running at 45 miles an hour, and having the right of way, collided with a local southbound passenger train which had slowed up and was within 100 yards of a siding which it was about to enter. A fireman of one of the engines, a postal clerk and a passenger were killed, the engineer of the local train was fatally and five others seriously injured.

A PECULIAR GRADE CROSSING COLLISION was reported at Allegheny, Pa., on April 9. The car had stopped in front of the Sandusky St. crossing of the Fort Wayne railway and the gates were down. The car suddenly started forward, crashed through the gate and struck the next to the last car of a mail train which was passing at the time, and was bumped by the last car. Eight persons were on the car at the time but only one was seriously injured. A few minutes before the accident the conductor of the car had reported at the dispatcher's office that the controller was "catching." The dispatcher got on the car and rode as far as the railway crossing but found nothing wrong with the controller.

REPORTS FROM THE MISSISSIPPI FLOOD are somewhat encouraging this week, notwithstanding the fact that the river is higher than ever before known and the area flooded greater in extent. The waters in the flooded district in the state of Mississippi are receding, and it is expected that they will disappear by May 1, and if this proves true, a fair crop can be made. President McKinley sent a special message to Congress recommending the passage of a bill for the relief of the sufferers, and a bill appropriating $200,000 was passed at once by both houses and signed by the President. At New Orleans the river is still rising and will probably continue to rise for a week or more. It has already passed the highest mark ever known. The levees in Louisiana are still holding, and an army of men is at work strengthening the weak places. It is believed that the flood will pass New Orleans without breaking through its levees.

A statement issued by the Weather Bureau on April 11 says:

> The total area under water on April 6 was about 15,800 square miles, of which 7,900 square miles were in Mississippi, 4,500 square miles in Arkansas, 1,750 square miles in Missouri, 1,200 in Tennessee and 450 in Louisiana. This region contained in 1890, so far as can be determined in view of the somewhat indefinite boundary lines of the flood, a population of 379,685, of which about one-half, 186,489, was in Mississippi, 100,235 in Arkansas, and the remainder almost equally divided between Missouri and Tennessee. Taking the entire region, the colored population outnumbered the whites in the proportion of twelve to seven. The flooded districts contain, it is estimated, about $39,500 farms. The total value of these farms, with their improvements, farm implements, etc., is close upon $65,000,000.
>
> What effect the flood will have upon the crops of the present season will depend upon the length of its continuance and the practicability of wheat planting after the subsidence of the flood. The entire region under water on April 6 produced last year about 370,000 bales of cotton, valued at close to $13,000,000; over 11,000,000 bushels of corn, worth about $3,400,000, and wheat, oats, potatoes and hay worth over $800,000.

A VERY COMPLETE GAS-ENGINE PLANT, with Dowson gas generators, is in use by the Arizona Copper Co. at Clifton, Ariz., running a concentration mill. It consists of four Otto-Crossley engines, each of 30 IHP. and two Dowson producers, each 4 ft. 4 in. diam., outside, by 7 ft. high, lined with 9-in. fire brick. Only one of these producers is used at a time. A gas tank, 10 × 12 ft., is also used. The whole plant was made by Crossley Bros., of Manchester, England. The coal used is anthracite, obtained from Cerillos, N. M., costing about $8 per ton. The plant develops on an average 110 HP. for 24 hours a day, 26 days in the month, with an average coal consumption of 1.05 lbs. per HP. per hour. The amount of gas used is 109 cu. ft. per HP. per hour. The plant has been in use since June, 1896, and practically no repairs have been required. Two men, working each 12 hours, give all the attention required. The Arizona Copper Co. is installing six more engines of the same make, but of greater power. With coal costing $8 per ton the low fuel consumption of gas engines should insure a large saving in cost of power as compared with that furnished by steam engines.

THE NEW DAM AT MINNEAPOLIS, built across the Mississippi River by the St. Anthony Falls Water Power Co., has been damaged by the recent floods. The extent of the damage is not made clear by the information at hand, but the indications are that some portion of the rollway has been carried out, owing to the washing away of the cribwork at the foot of the apron.

THE NEW SILVERWARE FACTORY OF TIFFANY & Co., at Forest Hills, N. J., in which is made some of the most artistic silverware productions of the world, has all its departments operated by electric power. The electric generators are two General Electric Co.'s moderate speed multipolar generators, each four-pole, 100-K.-W., 750-revolution, 250-volt machines, driven by belts from a countershaft, which is driven by a belt from a 250-HP. Corliss engine, built by Hewes & Phillips, Newark, N. J. To the countershaft is also belted a horizontal Ball & Wood engine of 50-HP., which is kept as an auxiliary engine for driving the machinery when the factory is running overtime with light loads. The countershaft is equipped with Worrall cut-off couplings, by which either or both of the generators may be driven. The leads from the generators are carried to the switchboard beneath the floor. From the switchboard the feeder circuits rise to the ceiling of the engine room, and are carried on porcelain insulators, in lines as straight as possible, to the various points of utilization in the factory. The motor equipment of the several departments is as follows:

Molding room	14	pole,	15-HP.,	1,200 revs.
Stamping and rolling room	14	"	30 "	975 "
Spoon-making room	14	"	20 "	1,050 "
Silversmiths' room	12	"	3 "	1,800 "
for small work	12	"	5 "	1,700 "
Stock room, blank cutt'g, etc.	12	"	5 "	1,700 "
Spinning room	14	"	8 "	1,600 "
Silversmith room	12	"	3 "	1,800 "
Gilding room	14	"	10 "	1,350 "
Etching and Enameling room	14	"	10 "	1,350 "
Engrav'g and die-sink'g room	12	"	3 "	1,800 "
Machine shop	14	"	10 "	1,350 "
Machine shop	24	"	15 "	1,200 "
Fan and blower room	14	"	30 "	975 "
Polishing room	14	"	10 "	1,350 "
Repairing room	12	"	5 "	1,750 "

The new building is lighted by 1,190 250-volt 16-c. p. lamps, and the old building, or plating department, by 199 250-volt 16-c. p. lamps, all furnished from the generators which supply current for the motors. The entire electric equipment was furnished by the General Electric Co.

A 10,000-HP. ROLLING MILL ENGINE has recently been built by Mackintosh, Hemphill & Co., of Pittsburg, for the steel works of Jones & Laughlins, in the same city. It is of the two-cylinder reversing type, the cylinders being each 50 ins. diameter and 6 ft. stroke. The 10,000 HP. is calculated on the basis of 1,000 ft. piston speed and 84 lbs. mean effective pressure, which high figures are sometimes reached in this type of engine. The dimensions of the engine are unusually massive. The three main shaft journals are each 24 ins. in diameter, two of them 36 ins. and the third 40 ins. in length. The pin of the double crank is 23 ins. diameter and 17 ins. long. The entire engine weighs about 800,000 lbs. It is directly connected to the polls in the steel mill, without intermediate gearing The engine is illustrated in "Power" for April.

CIVIL SERVICE EXAMINATIONS of candidates for the Department of Public Works in New York city are announced as follows: April 28, inspectors of pipes and pipe laying; May 3, laboratory attendant, bacteriological laboratory; May 4, building inspectors of masonry. Applications are desired for the positions of building inspectors of masonry and building inspectors of iron and steel construction; also for inspector of light, plumbing and ventilation in the Building Department.

A SYSTEM OF LONG-DISTANCE telephoning is reported to have been invented by Mr. D. McLaughlin Therrell, Southern Electrician of the Postal Telegraph Co., whose headquarters are at Atlanta. At an exhibition of the apparatus it is said that audible sounds were transmitted through resistances equal to 40,000 miles of ordinary telegraph cable. The result is obtained by having the original transmitter very powerful and by using repeaters which take up and magnify the sound at several stations along the line. For transatlantic telephoning it is proposed to have the repeaters contained in submarine chambers located 1,000 miles apart.

THE TRANSPORTATION AND ERECTION OF A PLATE GIRDER HIGHWAY BRIDGE.

We are indebted to Mr. W. H. Roney, C. E., Engineer and Superintendent of the Wabash Bridge & Iron Works, of Wabash, Ind., for the following description of the transportation of the material and the erection of a plate girder highway bridge, built by the above-named firm across the Wabash River, at Wabash, Ind. The bridge consisted of four 95-ft. spans, with masonry abutments and piers. The roadway was 34 ft. wide, in the clear, carried upon 5 floor-beams to each span, with two 8-ft. sidewalks supported on brackets outside of the girders. The piers and abutments were located at an angle of 27°, and the structure was designed to carry a live load of 100 lbs. per sq. ft. over both roadway and sidewalks. The girders were 8 ft. deep and each pair of girders weighed 40 tons.

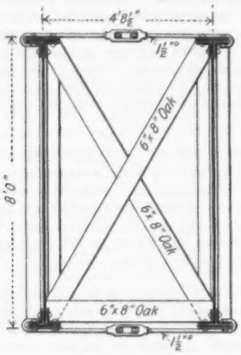

Fig. 1.—Braces and Clamps Employed to Connect a pair of Girders during Transportation and Erection.

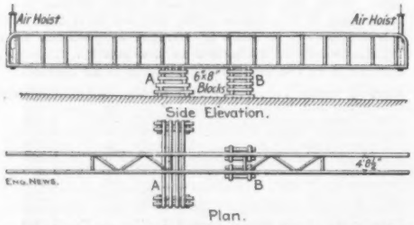

Fig. 1a.—Method of Lifting Girders in Shop, so that Cars may be Run under them.

The site of the bridge was between half and three-fourths of a mile from the railway station where the girders were delivered; and the loading and unloading of the girders and their transport over an ordinary gravel road, in none too good condition, are features of especial interest.

The girders were built at the shops of the Wabash Bridge & Iron Works, at Wabash, Ind. The erecting shop is provided with a system of overhead carriers, designed by Mr. Roney, and through the center of the shop runs a single track standard gage railway. Between the rails of this track are laid two light rails making a double track narrow gage railway. The girders, here referred to, were assembled and riveted up in pairs, so that each completed girder was located over one of the rails of the standard gage track and facing each other, as in the finished bridge. The two girders were then fastened together, as shown in Fig. 1, by four sets of 6×8-in. oak timbers, and 1½-in. iron clamps at the top and bottom of the girders. These sets of braces were about 18 ft. apart and divided the length of the girder into five panels, with the end sets 18 to 20 ft. from the end of the girders.

With the pair of girders thus securely clamped together they were hoisted up, three flat cars were run under them, and the girders were then lowered upon two oak bolsters, each 6×8 ins. by 8 ft. 6 ins., placed one upon each of the two end cars, nearly over the trucks nearest to the center car. The hoisting of the 40 tons of girders, to permit the cars to enter below them, was accomplished by two 3-ton air-hoists. To do this two stacks of cribbing were built, one on each side of the track, and extending from one to the other of these stacks were four 10×12-in. oak timbers. Two other stacks of 6×8-in. timbers were built, one under each girder, to be used as fulcrums, and both were placed near the center of the length of the girders. The pair of girders was then raised at the ends, alternately, by the air-hoist and the two sets of cribs were alternately built up until the desired height was reached. The cribbing under the girders was then removed, with the hoist still attached to one end, and the three cars were run under the girders between the other two stacks of cribbing. After the girders were placed upon the cars a coat of paint was sprayed upon them by a compressed air sprayer.

The pair of girders were carried by rail to within about one-half mile of the bridge site; here the girders were lifted by ordinary jack-screws and the two pairs of trucks, shown in Fig. 2, were placed under them. Heavy timbers were now laid on the cars as a track and the girders were hauled off the end of the cars by a hoisting engine. As indicated in Fig. 3, the girders had to be turned at right angles to the position of the railway tracks, about 150 ft. beyond the cars; and this was done by placing timbers under the center of

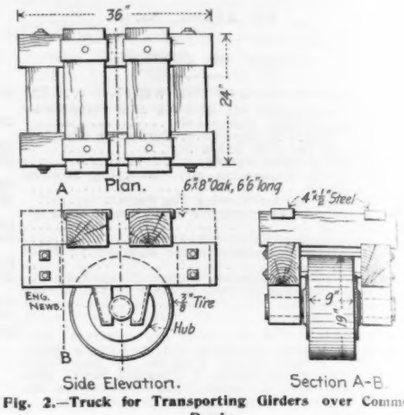

Fig. 2.—Truck for Transporting Girders over Common Roads.

the two girders, and on these timbers was laid a ring, about 7 ft. in diameter and made of ⅞-in. square steel. This ring, being well lubricated,

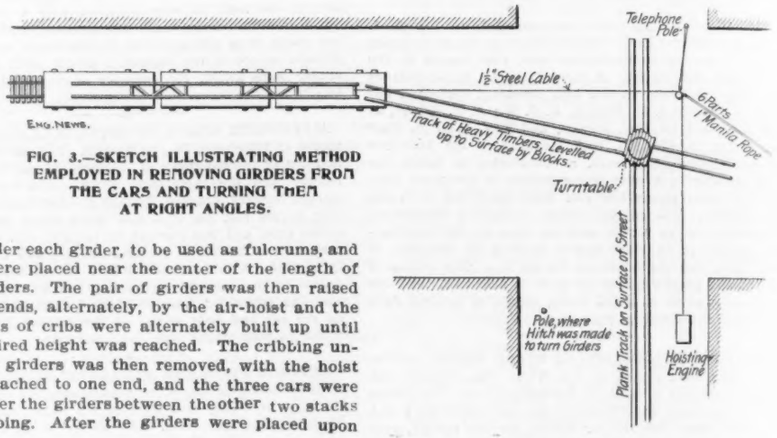
Telephone Pole
1½" Steel Cable
6 Parts 1" Manila Rope
Eng. News.
Track of Heavy Timbers, Levelled up to Surface by Blocks.
Turntable
Plank Track on Surface of Street
Pole, where Hitch was made to turn Girders
Hoisting Engine

FIG. 3.—SKETCH ILLUSTRATING METHOD EMPLOYED IN REMOVING GIRDERS FROM THE CARS AND TURNING THEM AT RIGHT ANGLES.

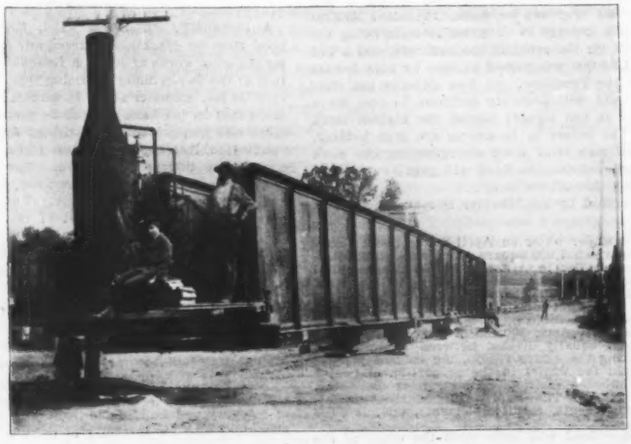

FIG. 4.—GIRDERS MOUNTED ON TRUCKS, WITH ENGINES IN PLACE FOR HAULING.

acted as a turntable, the trucks having been temporarily removed. After the girders were pointed in the proper direction, the trucks were replaced and heavy planks were laid down on the surface of the road for tracks. The hoisting engine was now mounted upon timbers projecting from one end of the pair of girders, and by utilizing a line of telephone poles along the road for fastening the snatch-block and tackle, the girders were hauled to the bridge. Several slight curves were passed and a 5% grade, near the bridge, was crossed upon falseworks made of two lengths of floor-beams (65½ ft.), with cross ties and planks.

The truck wheels used were especially designed and built for this purpose. These wheels were 19 ins. diameter, 9 ins. face, with a 4-in. axle of mild steel. The hub was made of cast-iron, 7 ins. square, provided with flanges 12 ins. diameter and 1½ ins. thick; the space between these flanges was filled in with well-seasoned oak blocks, tightly wedged, and turned off in a lathe. Over this was forced a tire of mild steel, 9 ins. wide by ⅜-in. thick. The truck-frame was 24-in. wide by 36-in. long, made of 6×8-in. timbers, and they were provided with cast-iron boxes open at the bottom, so that the frame and boxes could be lifted off. The pair of trucks was connected by two 6×8-in. oak timbers, 6 ft. 6 ins. long, laid closely across the two trucks. The planks first employed as a track were made of 3×10-in. green white oak, in 20-ft. lengths. This set of planks was badly crushed in transporting the first pair of girders, and 2-in. planks of green sugar or hard maple were next tried and gave satisfaction. The road over which the girders were transported were or-

dinary gravel or turnpike roads, not in good condition; but before starting the first load over them the worst holes and ruts were filled with crushed limestone. It should be remarked that the trucks

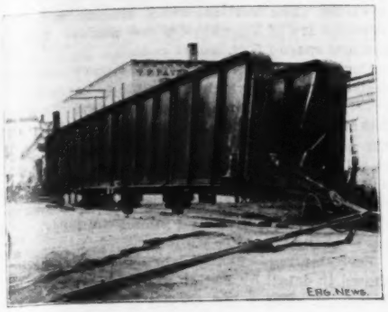

Fig. 5.—Forward End of Girders, with Hauling Tackle in Position.

were so placed near the center of the length of the girders that the ends overhung 30 to 40 ft. This arrangement made it easy to set a pair of light jack-screws under either end and thus free one set of trucks when it became necessary to turn the girders to the right or left on the remaining set of trucks.

The photographs herewith reproduced, show various steps in the transportation and erection of the girders. Fig. 4 is a general view of the girders mounted on their trucks, with the hoisting engine mounted at the rear of the girders, ready for hauling the girders along the roads. Fig. 5 shows the forward end of the same pair of girders, with the tackle attached. In Fig. 6, the first pair of girders have been brought to the bridge site with the forward end projecting sufficiently over the abutment to be utilized in lifting, by means of the hoisting engine, the first bent of the falseworks. Only two bents of falsework were used for each span, and in this view the bottom flanges of a pair of floor-beams can be seen, suspended between the main girders and ready to be lowered upon the bent, when the latter is set up and serving as a track for the further advance of the girders. Above this pair is a second pair, both being suspended between the girders before these are run out, and ready to be lowered upon the second bent of the falseworks. In Fig. 7 both bents are in position, with the first set of floor beams supporting the weight of the girders and the second set of beams being placed in position. The first set of beams has been clamped together and a track of 2-in. maple plank has been laid upon it for the truck-wheels. When the forward end of the pair of girders had been hauled over the end of the second set of floor beams the girders were in position to be lowered upon the masonry after being blocked up and the trucks removed. The floor beams were next unclamped, and again suspended from the main girders being swung around nearly at right angles to their former position.

The main girders were in turn now lowered with jackscrews onto steel beams sliding on greased plates on the top of the pier. The main girders of the first span were then unclamped, spread apart and set in their final position on the masonry; the floor beams were drawn up and riveted in their places and a steel joist was laid upon them as a track upon which to run out the second pair of girders ahead of the span already in position. Two sets of floor-beams were again suspended between the second set of main girders, and the end was again hauled forward about 35 ft. until the first bent of falseworks could be raised, when erection proceeded as before. The photograph, Fig. 8, shows the raising of the second bent of falseworks in the third span, with the two first spans in final position.

As there was quite a delay in waiting for the masonry to be completed, no attempt was made to do especially rapid work in handling the girders, but the following will give some idea of the time consumed in the several operations: Five men in 15 hours could lift the girders with ordinary jackscrews high enough to place the timbers and trucks needed for taking them off of the cars. The same men in 10 hours would haul the pair of girders 150 ft. to the point where they had to be turned at right angles. After being turned, 18 hours was the average time consumed in hauling one pair of girders a-half mile to the bridge site. In 12 hours 9 to 10 men could run the girders out from the abutment, raise the two trestle bents, lay the track and clamp the floor-beams, and securely block up the girders. Two days were generally consumed in lowering the main girders to place and suspending the floor-beams; 1½ days were needed for spreading the main girders, and another day for placing and riveting up the floor beams. No comparison in cost was made between the method adopted and the plan of hauling one girder at a time on heavy trucks drawn by horses. But as the two girders were clamped together at the shop, and not unclamped until safely lodged upon the masonry, it is believed that there was greater safety against overturning during transport and handling in this than by the ordinary method.

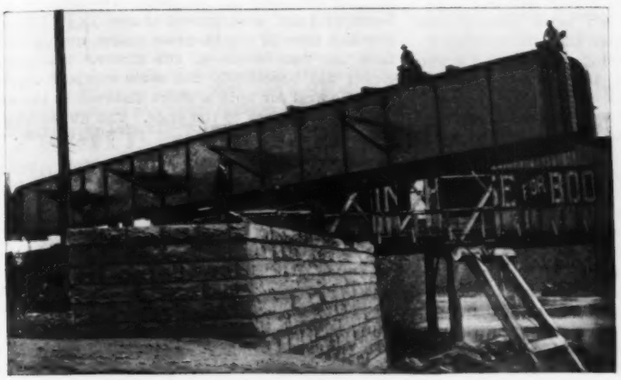

FIG. 6—FIRST PAIR OF GIRDERS RUN OUT OVER ABUTMENT AND USED IN LIFTING THE FIRST BENT OF FALSE-WORK.

FIG. 7.—FALSEWORKS IN POSITIONS; FIRST SET OF FLOOR BEAMS USED AS A TRACK, AND THE SECOND SET BEING LOWERED ONTO THE SECOND BENT OF FALSE-WORKS.

THE COMPREHENSIVE PLAN OF COAST DEFENSE, approved by the war department, contemplates mounting 710 12-in. steel mortars, 32 16-in. guns, 101 12-in. guns, 131 10-in. guns and 76 8-in. guns at the principal ports on the Atlantic, Pacific and Gulf coasts of the United States. The army bill passed by the last congress provides $10,000,000 for fortifications and guns, of which $4,600,000 will be paid out on existing contracts for 12-in. mortars and their carriages, shells and steel shot. New York Harbor will have the strongest batteries, with seven 8-in. guns, 24 10-in., 55 12-in., 14 6-in. and 150 12-in. mortars. There are already in place on the United States coast line 120 of the 12-in. mortars, 19 12-in. guns, 55 10-in. and 18 8-in. guns. The first 16-in. gun is now being made at the Watervliet Arsenal, and will be tested within a few months at Sandy Hook. This gun will weigh 125 tons and its projectile of over one ton in weight will require 1,000 lbs. of powder to propel it and pierce 31 ins. of steel at 1,000 yds.

FIG. 8.—TWO SPANS OF THE BRIDGE COMPLETED AND THE THIRD PAIR OF GIRDERS RUN OUT AND USED IN LIFTING SECOND BENT OF FALSE-WORKS.

SOME EXAMPLES OF RECENT PRACTICE IN TURNTABLE DESIGN.

(Concluded from p. 197—with two-page engraving.)

New York, New Haven & Hartford R. R. Co.

The standard turntable built by this company during the last year or two for its heavy locomotives is of wood, and as the company expresses a preference for it as compared with iron tables it is illustrated in some detail, in the several drawings of Fig. 1 to 3. It will be noticed that the table is rim bearing, instead of center bearing, that it has in addition end trailing wheels, and that it is 66.6 ft. in length. The other details are so clearly shown by the drawings as to make description unnecessary. Mr. F. S. Curtis, M. Am. Soc. C. E., Chief Engineer, New York, New Haven & Hartford R. R., states that the cost of this table complete is about $1,400.

Norfolk & Western Ry. Co.

The standard turntable used by this company is a plate girder, deck structure, 75 ft. long, designed to carry, in addition to the dead weight of the iron work with 400 lbs. per lin. ft. added for the track system: (1) A rolling load of 4,700 lbs. per lin. ft. over any part or the whole length, each half considered as an independent girder; (2) a rolling load of 3,600 lbs. per lin. ft., distributed over the whole turntable and supported entirely at the center. Under these loads the unit stresses are required not to exceed those specified in the standard bridge work of the company. All tables thus far built according to this standard have been constructed by the Virginia Bridge & Iron Co., of Roanoke, Va. For the accompanying drawings we are indebted to Mr. Chas. E. Churchill, M. Am. Soc. C. E., Engineer Maintenance of Way, Norfolk, & Western Ry.

Table.—The main girders are deck plate girders, 5 ft. ½-in. deep at the center and 2 ft. ½-in. deep at the ends from back to back of angles. The top chord is horizontal and the bottom chord for a distance of about 15 ft. at the center is parallel with the top chord, and then slants upward toward the ends at a slope of 1 in. in 10 ins. The top chord angles are 5 × 3½ ins., and there are four cover plates, of which the first is 75 ft. long and the others are 55 ft. 10 ins. long, 36 ft. long and 17 ft. long, respectively. The composition of the bottom chord is similar to that of the top chord. The web plates are ⅜-in. thick, and are stiffened by the usual angle and filler plate stiffeners. The girders are braced together by two plate cross girders, two end girders, eight vertical sway bracing systems, and a top and bottom triangular lateral system, disposed symmetrically with respect to the center. The plate cross girders and the end connections are parts of the end and center bearings, and will be described in that connection. The vertical sway bracing systems consist of top and bottom transverse angle struts and intersecting angle diagonals, and the top and bottom lateral systems are single angle diagonals extending between the opposite ends of the transverse struts in the planes of the chords. The angles are 3½ × 3 ins. in all cases. The track system consists of the usual cross ties laid directly on top of the girders, to which the rails are spiked.

Center Bearings.—The center bearing, Fig. 1, consists of the standard A carrying on its top a ring shaped cone roller track, a cap B with a corresponding cone roller track, and a yoke C supporting the table by means of hangers D passing through and suspending the cross girder, as shown by Fig. 2. The entire load travels on the cone rollers, seventeen in number, except of course such as goes to the end bearings. Details of the center bearing are best seen from the drawings.

End Bearings.—The general character and details of the end bearing are shown by the various drawings of Figs. 3 and 4. It will be noticed that the wheels swing clear when the table is level, also that the masonry is protected from shocks by a wooden cushion. Details are shown by the drawings.

Foundations.—The foundations are of rubble stone or brick in cement masonry. The center pier has a dressed and leveled capstone 5½ × 5½ ft., with its top 6 ft. 3⅛ ins. below the base of rail and resting on a foundation stepping down in 12-in. courses to a 16 × 16 ft. bed course. The character of the side walls is shown by Fig. 5. The bottom of the pit slopes radially toward a sump near the center and this sump is drained by means of a 10-in. tile drain passing through the side walls to the outside of the pit.

Pennsylvania Lines West of Pittsburg.

The latest turntable used on these lines is made by the Edge Moor Bridge Works, of Edge Moor, Del., and is of special design in several particulars. We illustrate a 65 ft. 1½-in. plate girder, deck table, the drawings of which have been furnished by the Edge Moor Bridge Works. All material, except of course the castings, is wrought iron.

Table.—The main girders are riveted plate girders 65 ft. 1½ ins. long over all, 5 ft. deep at the center, 2 ft. 9 ins. deep at the ends, and spaced 5 ft. ½ in. apart c. to c. The top chord is horizontal and consists of two 3 × 5 × 7-16 ins. angles and four cover plates, all 14 ins. wide and ½ in. thick, and 65 ft. 1½ ins., 54 ft. 1 in., 21 ft. ½ in., and 15 ft. ½ in. long, respectively. The bottom chord is horizontal for a distance of 15 ft. 3½ ins. at the center and then bends up toward the ends. The web plate is spliced at these bends, with two 3½ × 3½ × ⅜ ins. angles and a 7 × 7-16 ins. plate, and has also 22 stiffeners, each consisting of two 3½ × 3½ × ⅜ ins. angles and two 3½ × 7-16 ins. fillers besides the center and end cross girder connections. The two main girders are braced together by the center and end cross girders, four vertical sway bracing systems, and a top and bottom lateral system, all disposed symmetrically with respect to the center. The vertical sway bracing systems, two on each side of the center, divide each half of the table into three panels. For the two inner panels there are top and bottom lateral systems, but for the outermost or end panel there is only a top lateral system. The character of the vertical sway bracing and the lateral systems is unusual, and is shown by Figs. 1 and 2. It will be noticed that both systems are adjustable.

Center Bearing.—To support the table on the center pivot two lateral girders are riveted to the main girders by angle connections, and carry between them the I-beam cross girder which rests upon the cast yoke. This center bearing is shown by Fig. 3, in which A is the post, B the lower casting, C the upper casting and D the yoke. It will be noticed that this pivot allows the table to tip longitudinally, but not transversely. Other details are shown by the drawings.

End Bearings.—The end bracing systems and supports for the trailing wheels are shown by Fig. 4 in full detail and no further description is necessary.

Pennsylvania R. R. Co.

This company uses 60-ft. and 70-ft. riveted plate girder, deck turntables, with the Piper center bearing, made by the Keystone Bridge Works, now controlled by the Carnegie Steel Co., Ltd. The 60-ft. table is the one in most common use, the 70-ft. table being designed for use at important terminal points, where there is frequently occasion to turn dining cars and other cars too long to be accommodated by the 60-ft. table. The girders for both tables are designed for the typical engine used in the company's standard bridge specifications, which has a weight of 100 net tons on a wheel base of about 50 ft. Heretofore the cost of these tables, including center, has been about $1,300. Mr. Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer, states that up to the present time these tables have shown ample strength and stiffness. For illustration the 60 ft. table has been selected.

Table.—The main girders are 60 ft. long over all, 4 ft. 6½ ins. deep at the center, and 2 ft. 3½ ins. deep at the ends. The top chord is horizontal and is composed of two 5 × 4 × 7-16 ins. angles and three cover plates, 12 × ½ ins. × 60 ft., 12 × ½ ins. × 40 ft. 5 ins., and 12 × ⅜ × 25 ft. 9 ins., respectively. The bottom chord is horizontal for a distance of 20 ft. at the center, and then bends up toward the ends, and has the same composition as the top chord except that the cover plates are 60 ft. 3 ins., 43 ft. 10 ins., and 33 ft. 4 ins. long. The web is ⅜-in. thick, and is spliced at the bend of the bottom chord with an angle and filler plate splice. There are also eight web stiffeners [illegible] 3½ × ⅜ ins. angles and 3½ × 7-16 ins. fille[illegible] To brace the girders together there are end and center girders, four vertical sway bracing [illegible]ems and top and bottom intersecting diagonal [illegible]eral systems. The vertical sway bracing and [illegible]eral systems are of 3½ × 3½ × ⅜ ins. angles. The girders are spaced 5 ft. apart c. to c.

Center Bearing.—Fig. 1 shows the center [illegible]der construction by which the table is carried [illegible] the pivot, in the manner explained by Fig. 2. [illegible] Fig. 2 A is the center stand, B the ring plate, [illegible] the cap plate, D steel cone rollers, E and F steel bevel rings, G the spider carrying the cone rollers, H a wrought iron ring, I a brass bearing, K the cap covering hole at the 4-in. steady pin, and L a ring washer to keep the spider in position. All parts of the pivot are standard.

End Bearing.—The end bearing construction is shown in detail by Fig. 3, and need not be further described. Fig. 4 is a sketch showing the pit and foundation construction.

Pencoyd Iron Works.

The standard turntable built by this company and furnished to various railways during the past few years is a riveted plate girder deck structure 60 ft. long calculated for a 100-ton consolidation engine load. The main girders are 5 ft. [illegible]-in. deep, back to back, of angles at the center and 1 ft. 11½ ins. deep at the ends. The top chord is horizontal and is composed of two 5 × 4 × 7-16 angles and four 12 × ½-in. cover plates, one of which runs the full length of the girder. The bottom girder has practically the same composition, but is horizontal for only a short distance at the center and then rises to the ends. The girder web is ⅜-in. thick and is stiffened by 3½ × 3½ × ⅜-ins. angles and filler plate stiffeners.

Fig. 1 shows the construction of the center pivot and bearing, in which A is a cast steel standard, B a cast steel ring bolted to the standard, C hardened steel disks, D a phosphor bronze disk, E a cast steel yoke with a dust cover, and F the saddle girder with suspending rods. It will be seen that the suspending rods are designed to adjust the height of the table. In placing this pivot the standard A is placed high enough above the circular track rail to allow all four trailing wheels to clear the track 1 in., when the table is level and without an engine upon it. The load is intended to be carried entirely upon the center disks, the wheels being used only to steady the table in turning. Also the top cross channels F should never be screwed up rigidly to the channels G. The end bearings consist of channel cross girders to which the trailing wheels are attached by means of cast steel boxes. The total weight of this table complete is 36,000 lbs., and it has given good results in use.

Union Pacific System.

This system has no standard turntable of its own design, but uses the standards of various manufacturers. In most cases also the tables used were installed previous to 1890, so that not even the most recent constructions of these manufacturers are used in all cases. In a general way, however, the record of experience with these tables is valuable in determining the practical requirements demanded of more modern structures, and from information furnished by Mr. Geo. H. Pegram, M. Am. Soc. C. E., Chief Engineer, we are able to give this record quite fully. This is by divisions as follows:

Nebraska Division.—The turntable at Omaha is one of our own pattern, and was put in about 21 or 22 years ago, giving us little or no trouble, with the exception of not being long enough to take in our modern engines with the 4,000 gallon tank. The table at Council Bluffs is Greenleaf pattern, put in in 1887 and gives good satisfaction, no trouble with it, with the exception of occasionally putting in some new friction rollers and center bolts. The Grand Island turntable is a Cofrode & Saylor table, put in in November, 1888. We have no trouble with this table, with the exception of occasionally breaking the axles of the small wheels at the end. Have increased this axle from 2 ins. to 2½ ins. and overcome this trouble. This table springs a little with our heavy engines, and is a little difficult to exactly balance, but a couple of men can handle it. With the other class of engines, however, two men turn it in good shape. The table at Sidney is iron, built by the Edge Moor Iron Co., of Edge Moor, Del., in 1881, placed in service at Sidney, came from Kansas Division about five years ago. We

Summary of General Structural Characteristics of Eight Different American Railway Turntables.

Name.	Style of table.	Length of girders. ft.	ins.	Depth of girders at center. ft.	ins.	Depth of girders at ends. ft.	ins.	Distance of girders apart. ft.	ins.	Style of vertical bracing.	Top lateral system.	Bottom lateral system.	Thickness of web ins.	Load.
Lake Shore & Michigan Southern Ry.	Deck.	62	0	4	6½	2	2	4	7⅛	X frames	Single triang	Single triang	⅝	.....
Lehigh Valley Ry.	"	50	6½	4	6	2	4	5	0	"	"	"	⅝	4,000 lbs.*
Minneapolis, St. Paul & Sault Ste. Marie Ry.	"	60	0	4	6	2	0	5	0	"	"	None.	⅝	105-ton loco
New York Central & Hudson River Railroad	Through.	57	6	4	6½	2	6½	11	9	floor girdrs	None.	D'ble triang.	⅝	.....
Norfolk & Western Ry.	Deck.	75	0	5	0½	2	0½	5	0	X frames	Single triang	Single triang	⅝	3,600 lbs.*
Pennsylvania Lines West of Pittsburg	"	65	1½	5	0	2	9	5	0½	"	D'ble triang.	D'ble triang.	⅝	.....
Pennsylvania Railroad	"	60	0	4	6½	2	3½	5	0	"	"	"	⅝	100-ton loco
Pencoyd Iron Works.	"	60	0	5	0½	1	11½	5	0	"	"	None.	⅝	100-ton loco

*Per foot.

have considerable trouble with this table not balancing with an 1,800 class engine. This is mostly due to the fact that the table is only about a foot longer than the engine, unless the tank is full of water and coal it is quite hard to turn. Center castings broke on this table about two years ago, outside of this we have had no trouble, with the exception of occasionally, during the cold weather, breaking one of the 2½-in. center bolts. The table at North Platte was built by Cofrode & Saylor and put in in 1889 and is not giving us a particle of trouble. The table at Beatrice was built by the Detroit Bridge & Iron Works in 1886, and placed in service in 1887. This table was sprung while being put in place and has never turned as easily, in my judgment, as it should, however it is first rate. The only trouble we have had is the occasional breaking of wheels, probably put in five since the table was applied. When we had the table out facing the foundation last year we found the center castings cracked, but not enough to impair its service.

Idaho Division.—At Pocatello and Montpelier we have 60-ft. Edge Moor turntables. At Glens Ferry we have a 60-ft. wrought iron table built by Cofrode & Saylor, Philadelphia Bridge Works. At Lima we have a 60-ft. wrought iron table made by the American Bridge Works, Chicago. At Dillon we have a 60-ft. cast iron table (supposed to be made of gun metal) made by C. A. Greenleaf. At Salt Lake we have a 50-ft. cast iron table, no maker's name; probably a Sellers, or may be a Union Pacific pattern. There is no question whatever but what the Edge Moor tables are far superior to the others, and give much better service all around. The Greenleaf table at Dillon turns equally as easy as the Edge Moor tables, and in addition to the roller bearings on top of pedestals, has roller bearing against the outside of pedestal, but there is a perceptible spring or deflection to the outer ends of the table with our 1,400 class engines and presume if it was used as much as the tables at our terminals it might not hold up as well as it now does, as, since being placed at Dillon there has been not more than an average of one or two engines turned per day. It has no roller bearing at the end of table and is dependent entirely upon the center, or pedestal bearing. The turntables at Lima and Glens Ferry are much harder to turn than the Edge Moor tables, as it takes from three to five men to turn them at these two points, whereas one or two men can turn the Edge Moor table. We think the Lima and Glens Ferry tables are equally as strong as the Edge Moor tables, and the trouble mentioned is probably owing to defective pattern of center bearing. The only perceptible defect to the Edge Moor tables is that the cross end frames which hold the carrying wheels (traveling on the circular rail) are rather light, and on the table at this point we had to renew them, substituting 6-in. angle iron for the lighter angle iron which was originally put on by the builders. This is about the only repairs we have made on any of the tables mentioned since they were placed in service here, with the exception of the old cast iron table at Salt Lake.

Kansas Division.—At Armstrong we have a Wm. Sellers Edge Moor patent table, 53 ft. 6 ins. long. This table is too light for the heavy engines to be turned on it and we applied truss rods to it some three years ago in order to strengthen it. At Junction City, the table is of Edge Moor, Del., Iron Co., manufacture, 53 ft. 6 ins. long. This table as well as the one at Armstrong is too short to properly balance engines with 4,000 gallon tanks and consequently turns hard. Both tables are too light to have heavy engines turned on them. The table at Ellis was built by Haugh & Co. at Indianapolis and is too light and too short to turn heavy engines and has been reinforced with truss rods in order to make it hold up. The table is 53 ft. 5 ins. long. Engines cannot be properly balanced on it on account of being too short. The turntable at Cheyenne Wells was built by the Edge Moor Iron Co., and is 55 ft. long. This table has also been reinforced by truss rods in order to make it hold up. The table at Leavenworth was made by Greenleaf and is 55 ft. long. On account of the light class of engines used on the branches out of Leavenworth this table is giving good satisfaction. At Belleville, Beloit and Lawrence we have wooden tables, home-made, called the Prairie table. These answer very well for the purpose, as all of them handle light engines.

Colorado Division.—We have only one turntable on this Division in service at present, which is here at 40th St. shops in Denver, Colo. This table is an Edge Moor and has been in service about six years, turning on an average of over 50 engines per day with little or no repairs.

Wyoming Division.—We are using at Laramie, Rawlins, Green River and Ogden 60-ft. turntables, manufactured by the Edge Moor Iron Co., of Edge Moor, Del., and at Evanston an old Greenleaf table 55 ft. that was formerly at Armstrong, Kans. These tables were put in service in 1890, I think, and have given good satisfaction. The only trouble we have found with them is that in the end carriage the frames are too light (have had to rebuild them of stronger angle iron and heavier iron), otherwise the tables work well under our 1,300, 1,400 and 1,800 class engines, but the 1,600 class cause them to spring some from center to ends when they go on. We have had to truss them and have had to increase the strength of original center casting in order to carry up our 1,400 and 1,800 class engines.

The various engine loadings mentioned are shown by the accompanying diagrams. It will be noticed that the most common trouble with these old tables is lack of strength to carry the heavy modern types of locomotives, it having been necessary in several instances to add truss rods and to increase the size of members particularly in the end frames.

General Summary.

It will be seen from the foregoing descriptions that of the ten turntables illustrated, eight are plate girder deck structures, one a plate girder through structure and one a high truss wooden structure. As the plate girder through turntable was designed for a special case and as the designer recommends the deck table for ordinary conditions, it may be said that only one exception to the plate girder steel or iron deck turntable is found in standard use among the dozen railways whose practice in turntable construction is given in this article. To enable a comparison of the deck tables illustrated, their principal dimensions have been summarized in the accompanying table. It will be noticed from this table that as far as the general design of the table proper is concerned there is a pretty close accordance of practice among the various designers. The chief difference in design seems to be in the style and character of the lateral bracing systems. Many other points of similarity and dissimilarity will be seen upon examining the descriptions and drawings. It having been the purpose of this article to illustrate only dissimilar center bearing construction it of course follows that any determination of the center most preferred is not possible. In a future article it will be the purpose to carry this comparison of turntable practice further to include many popular and deserving constructions not mentioned here.

ENGINEERING COMPENSATION.*

By M. S. Parker, M. Am. Soc. C. E

How seldom does the old and experienced civil engineer advise the young man about to begin his career in life to adopt the profession of civil engineering! To his brother engineers the reason is obvious. The practice of the profession does not offer pecuniary inducements commensurate with the study, hard work, and experience necessary to possess the title C. E. in its fullest meaning.

The preliminary education necessary for the civil engineer is not less than that required for any other professional calling, and the subsequent training is as exacting in its requirements.

The civil engineer ripe in experience, has passed through an ordeal of preparation that should entitle him to the highest consideration among the professions and a proper remuneration for his services. Alas, how seldom is this the reward for valuable service rendered! The maximum compensation for engineering services is at best meager when compared with the compensation for other professional service. The railways of the world have given employment to a large majority of the civil engineers during the past fifty years. There is probably no class of professional men who have rendered more valuable service to the world at large than the civil engineers employed in building the railways, and probably no class of men have received less compensation for services rendered. The same amount of time, energy, and hard work expended in any other direction would bring to this class of men their well-earned reward.

How contrary is the experience of those employed in this great work of civilization! The compensation for such services is barely sufficient, with proper economy, to support a man with a family from month to month. Should disability or loss of position occur, there is no bank account possible to tide over any considerable loss of time. The engineer engaged in this line of employment loses touch with other branches of his profession. His main reliance is on railway work. This means unsteady employment. The result is well known to engineers.

The plums are very scattering in the pudding. Permanent positions are few as compared with the transient positions. The ever-to-be-feared order for reduction of expenses is a constant menace to the quasi-permanent employed engineer, and makes his tenure of office very uncertain.

The architect, the near relative of the engineer, receives his compensation according to the magnitude of his work. The larger the sum of money to be expended under his direction, the larger the amount of his commission for services.

The lawyer receives fees according to the magnitude or importance of his case, and leads all professions in the matter of compensation for services rendered. The physician is rewarded for professional services according to his ability and experience. The physician having climbed the ladder of successful practice has no limit to his charges except his tender conscience. Running through the list of professions open to the young man, we find, for pecuniary success, the profession of civil engineering offering the least inducement of them all. For immediate results, possibly the engineeering profession is the leading one. The young graduate engineer secures almost immediately in times of prosperity a position that might be the envy of his fellow-student in some other profession, both for its responsibility and the accompanying pecuniary reward, but here such envy should cease.

Let us look ahead ten years. Should the young engineer have cast his lot among railway builders, he has acquired ten years of valuable experience in this line of work—knowledge that cannot be obtained except by such experience. His services have become more valuable to his employer, but his salary has not increased with his usefulness. The difference in compensation between the first position secured and the position after ten years is not material, and we may add another ten years, and the difference is less proportionate.

One instance will illustrate this. A company proposes to build a railway. An engineer is selected to locate the road. This selection is made with regard to the ability and experience of the engineer. The expenditure of millions of dollars is placed under his direction, relying on his ability and judgment to make the best selection as to location and the most economical expenditure of the money. This large expenditure is left almost entirely to his judgment, the projectors of such enterprises, as a rule, having little knowledge about such matters. His immediate superior is a chief engineer, whose duties are more of an executive and advisory nature. It may be said that the engineer in the field is the sole responsible person for the economic location and construction of a railroad. This engineer, having the expenditure of millions of dollars under his direction, has a great responsibility resting upon him, as all must admit. Mistakes in judgment can cost his employers large sums of money. The engineer who by education, experience, and ability is fitted to take this responsibility upon himself receives the munificent monthly compensation of possibly $200, seldom much more, and often less. This compensation is for transient monthly service, his tenure of employment expiring with the completion of the work. In what other line of professional employment can be found a greater responsibility with so little pecuniary compensation? Americans are led to believe that they are the best-paid people in the world, and in most instances this is true. As applied to civil engineers, however, the statement is incorrect. In England the compensation for engineering services is far above the standard of the United States, and ranks the profession nearer on an equality with the other recognized professions. Wherein lies this poor appreciation of the services of the civil engineer in this country?

The author is led to believe that it lies wholly with the

*Address at the Tenth Annual Meeting of the Montana Society of Civil Engineers, held at Great Falls, Montana, January 9, 1897. Reprinted from the "Journal of the Association of Engineering Societies," February, 1897.

members of the profession themselves. The tendency has been to depreciate the pecuniary value of their services. The present system of competitive bids for engineering service is one of the depreciatory measures in existence, and is very detrimental to the prosperity of the engineering profession, very demoralizing in its effects upon legitimate compensation. Such methods of obtaining professional service should be completely ignored by engineers as being unprofessional and beneath their dignity. An individual or corporation does not ask for bids for legal services. The individual in need of a surgical operation does not ask bids from surgeons to perform the operation, neither does the head of a family ask for bids for medical attendance of his family for a period of time.

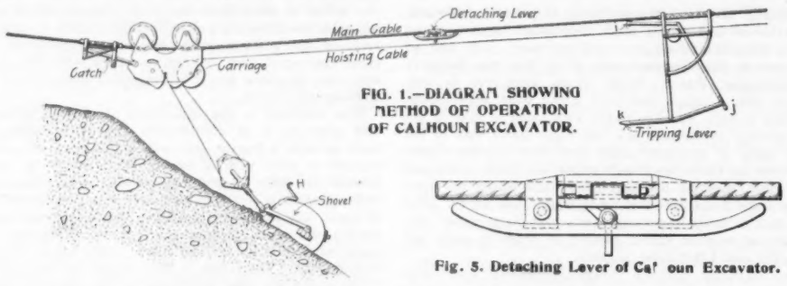

FIG. 1.—DIAGRAM SHOWING METHOD OF OPERATION OF CALHOUN EXCAVATOR.

Fig. 5. Detaching Lever of Calhoun Excavator.

How many reputable attorneys or physicians would so lower their professional standing as to enter into any such competition? Yet this is a growing practice in this country in acquiring engineering service. It is not difficult to comprehend where the encouragement of this practice will lead the engineering profession.

One instance that the author has in mind of the many that have come to his attention will serve to illustrate this practice. A Southern city desired to make extensive municipal improvements, establish a sewerage system and grades of streets and pavements, the entire improvement involving the expenditure of about $400,000. The city fathers had appropriated $15,000 for engineering expenses, including superintendence—a reasonable amount for the services expected. They then asked for bids for plans,

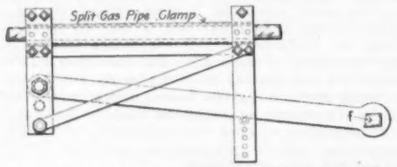

Fig. 3.—"Catch" or Carriage Locking Device of Calhoun Excavator.

specifications, and superintendence of the work projected. The Board of Public Works desired to engage a certain engineer of long experience and high standing to do the work, but under the resolution of the City Councils, bids must be submitted for the required service. The engineer who was the choice of the board submitted a proposition, but not in the nature of a competitive bid—merely a reasonable figure for his services. What was the surprise of members of the board and of the engineer selected, on opening the bids to find offers from engineers who are recognized as authority upon such matters proposing to do the work for about one-half of one per cent. of the proposed expenditure, and about one-third of the sum proposed by the engineer chosen by the board. The bid accepted for the entire work was $2,200. This bid was from a prominent and well-known civil engineer of New York. There was such a gulf of difference between the lowest bid and the proposition of the engineer selected that, in the face of public opinion, the contract had to be awarded to the lowest bidder—a very erroneous practice in vogue among municipal corporations, as the sequel often proves.

Such methods of practice cannot be too severely condemned by the civil engineering profession. They lead to careless and inefficient work, and thus bring discredit upon the profession. What standing can be expected by the profession at large when its leading members so lower their professional dignity? Does it not place the profession on a par with a commercial body? There should be a code of professional ethics among civil engineers that would not tolerate such practice. Such practice should be stamped out in its infancy. To encourage it means the degeneration of the profession in the future. If executive ability, combined with knowledge of the science of civil engineering, is not to be appreciated in the engineer, why devote his life to it, when other avenues of life are open to him in which he may find honor and proper compensation for the faithful performance of his duties? There comes a time in the lives of all men when work is impossible. It is the duty of every man to provide against such a time. Should the civil engineer be obliged to work his life through for the bare privilege of living from day to day, knowing that when health or strength fail him he is to become an object of charity? How many engineers recognize this fact as they advance in years, and seek to better their future financial condition by engaging in other more remunerative occupations? This is not done from choice, as the civil engineer loves his profession, but as a matter of necessity to provide against future want. This is a sad commentary upon the profession in this country; still, it is true. The poverty of engineers is proverbial. Is it strange that the old engineer advises the young man to avoid the profession and cast his lot in some other vocation?

The profession of civil engineering is as old as history. It is one of the most honorable and noble of callings. Its members have rendered invaluable service to mankind, and stand upon the roll of honor of the world's greatest benefactors, and it is greatly to be regretted that so noble a vocation should be so poorly rewarded in this world's goods.

THE CALHOUN EXCAVATING AND CONVEYING MACHINE.

We illustrate in the accompanying cuts a cableway excavating and conveying device which has been used quite extensively in handling gravel, broken stone, coal and similar materials and, which, with several improvements, is now being built for sewer and ditch work as well as for the various other uses. The excavator is the invention of Mr. D. Irving Calhoun and is fully protected by American and foreign patents granted and pending. For the information from which this description has been prepared we are indebted to the Calhoun Excavator Co., 741 Unity Building, Chicago, Ill.

The diagram Fig. 1 explains the general operation of the excavator, and Figs. 2 to 5 inclusive, show in detail the construction and operation of special parts. Considering Fig. 1 first, it will be seen that the machine is shown at the moment the shovel is filling itself. The shovel is drawn up the bank and filled and is then hauled up to the carriage and locked. At the same time the carriage, which during excavation is locked to the catch, is released and left free to be pulled back along the main cable until it reaches the tripping lever. This unlatches the bail, permitting the bucket to turn bottom up and empty its contents. By means of a tail rope the carriage is then hauled back toward its original position, passing on the journey the detaching lever which unlocks the shovel sheave from the carriage so that the shovel can be let down to the ground ready to take a new load. All the locking, dumping and unlocking movements are accomplished automatically.

Summarized now it will be seen that the excavator consists first of a main cable running between two end towers and carrying the catch, tripping lever and detaching lever fixed to it, and also the movable carriage supporting by means of the lifting rope the sheave carrying the shovel; and second of a tail rope to give the reverse motion to the carriage. On the right hand or rear tower is located a hoisting engine and boiler for operating the lifting and tail ropes which move the carriage and shovel. Evidently the constructions of chief interest are the shovel, carriage and the various locking and tripping devices. To understand these clearly it is necessary to examine first the carriage, which is shown by Fig. 2.

The carriage consists of two steel side plates, A and B, carrying the traveling sheaves, C and D, the hoisting rope sheave E, and the locking apparatus consisting of a "tumbler," "hook" and "locking lever." When the shovel is on the ground the right end of the tumbler, which is pivoted at F, falls so that the face a b rests on the bearing c d, that is, the tumbler is in position to receive the sheave G as it rises into the carriage. In this position of the tumbler the locking lever is not engaged with the notch e, but the carriage is attached to the catch by means of the cross bar f (Fig. 3), which rests in the notch g of the carriage hook. Now as the shovel rises from the ground the sheave G passes up between the side plates of the carriage and the hubs h enter the tumbler notch and revolve the tumbler up and toward the left. At a certain plainly observed position of this revolution the locking lever operated by springs enters the notch e, and a little further on the right end of the tumbler strikes and lifts the right arm of the hook, freeing the catch at g. The carriage now has the load locked to it and is free to be pulled to the tripping lever.

The construction of the tripping lever is shown quite clearly in Fig. 1. Like the latch, it is clamped to the main cable by means of a split gas pipe clamp and thus is adjustable at any point on the cable. Its essential operating feature is the compound lever i j k. As the carriage reaches the tripping lever its approaching face strikes the arm i and at the same time the arm k hits the latch crank H (Fig. 1), and throws it open so as to free the bail of the shovel bucket. Fig. 4 shows the shovel or scoop and its latching attachment in more detail. The load being dumped the carriage is hauled back and in the journey the detaching lever, Fig. 5, strikes the locking lever in the carriage, Fig. 2, and frees it from the notch e. The weight of the shovel bucket then pulls down the tumbler and frees the hubs h, allowing the sheave and bucket to be dropped to the ground by means of the hoisting rope.

Among the special points to be noted in what has been described are that all shocks of locking and dumping are brought onto the main cable and not onto the hoisting rope; every operation is accomplished mechanically and automatically, and all locking and unlocking movements are positive in their action. Attention may now be turned to the purely structural features of the excavator.

The carriages are made in three sizes to handle, respectively, ½ cu. yd., 1 cu. yd., and 1½ cu. yd. buckets, and with the exception of the sheaves are entirely of steel. Suitable sized carrying sheaves for the main cable are provided for the different sizes of carriages. These sheaves have detachable rims of especially hard iron to give them great wearing power, but the hoisting sheaves are ordinary good quality cast iron. For the three sizes of carriages the hoisting cables are ½-in., ⅝-in., and ¾-in. in diameter, respectively. Turning to the catch, Fig. 3, it will be seen that the locking arm has a vertical movement, and that it consists of two bars hinged at one end and diverg-

FIGS. 6 AND 7.—VIEW OF CALHOUN EXCAVATOR AT WORK HAULING GRAVEL.

ing at the other end where the cross bar f holds them together. The detaching lever shown by Fig. 5 needs but little description, except to note that the horizontal horns are simply guides to direct the device through between the side plates of the carriage so that the dog will catch the locking lever. This dog, as will be noticed, is free to swing aside without tripping the locking lever during the backward travel of the carriage but offers a rigid projection to trip the lever upon the return travel.

Turning to the bucket or scoop shown in Fig 4, it needs to be noted that this is provided with sockets for handles to be used by the pitman to feed it into the material, and also that the ball connection with the sheave is adjustable so that a light or heavy feed can be had according to the material. The bucket has also been designed to have large capacity in proportion to its height, a wide throat for the entrance of material and a curved bottom centered at X, Fig. 4, so as to allow of easy tipping to a heavy or a light feed by means of the rear handles. The operation of the latch will be readily understood from the drawings.

As to the approximate capacity of the machine and cost of handling material with it, we understand that on a haul of about 250 ft., one trip a minute has easily been made. With that speed for ten hours using a 1 cu. yd. shovel, 600 cu. yds. of material can be handled. To operate the excavator requires an engineer or fireman at $2 per day, a man to control the drums at $2 per day, and a man at the shovel at $1.50 per day. The machine will use from 1 ton to 1½ tons of coal per day depending upon the size of the hoisting engine. The cost of this fuel together with the cost of waste, oil, etc., has of course to be added to the wage expense.

Heretofore the excavator illustrated has been used mostly to handle gravel, broken stone, coal, etc., and Figs. 6 and 7 are views of the excavator working in a gravel bank. A new use to which the designer has adapted the system, however, is the excavation and back filling of sewer trenches, as shown by Fig. 8. This illustration is self-explanatory in connection with what has gone before, and the possibilities of the system can be studied by our readers for themselves.

The list prices of the three sizes of carriages and shovels are as follows:

No. 2 carriage with sheave-block and catch	$325
No. 4 carriage with sheave-block and catch	400
No. 6 carriage with sheave-block and catch	475
No. 2 shovel with tripping lever, ½-yd. capacity	325
No. 4 shovel with tripping lever, 1 yd. capacity	400
No. 6 shovel with tripping lever, 1½ yds. capacity	475
Detaching levers, all sizes	35

At present these excavators are being used by the Buffalo Cement Co., of Buffalo, N. Y., for handling of broken stone, by S. S. Start & Co., of Elgin, Ill., for handling gravel, and by several other contractors.

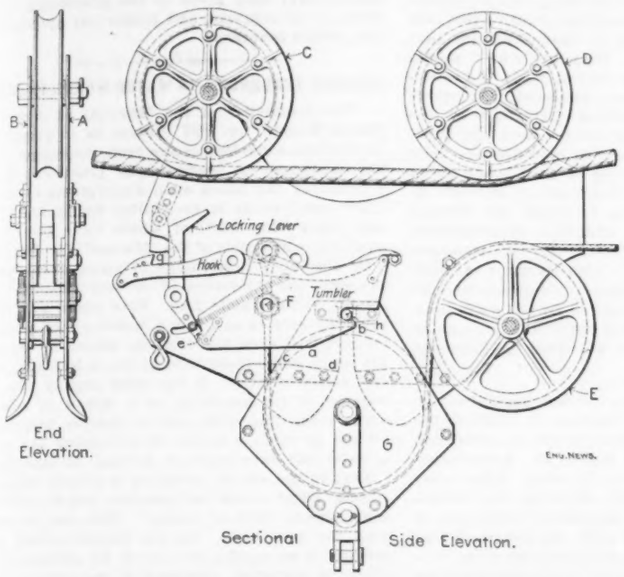

FIG. 2.—CARRIAGE CONSTRUCTION OF CALHOUN EXCAVATOR.

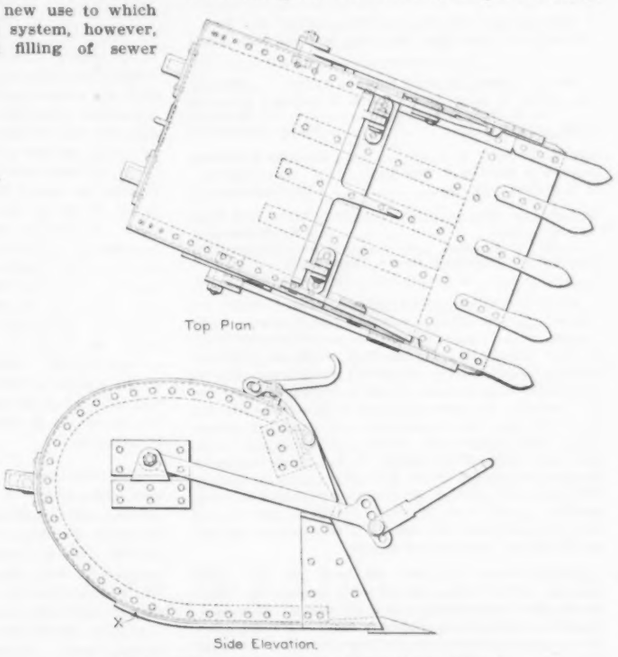

FIG. 4.—SHOVEL BUCKET OF CALHOUN EXCAVATOR.

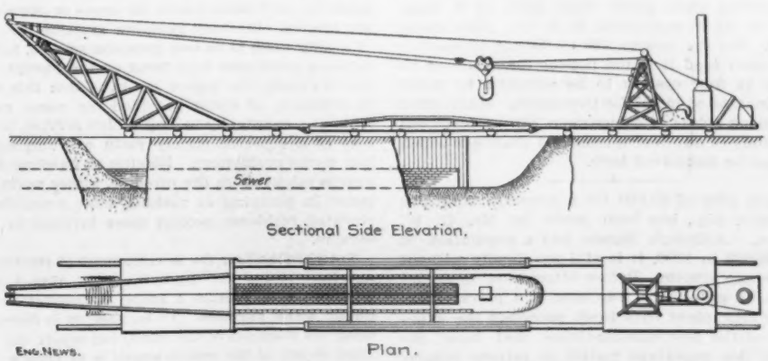

FIG. 8.—CALHOUN EXCAVATOR APPLIED TO EXCAVATING AND BACK FILLING SEWER TRENCHES.

COMPRESSED AIR FOR BLOWING FOG SIGNALS.

The U. S. Lighthouse Department has for some time devoted much attention to the improvement of its fog signals, and to that end has recently adopted compressed air in place of steam for sounding fog signals. A very compact plant has been developed for this service, and one is now being installed at Montauk Point, on the extreme eastern end of Long Island. The motive power is furnished by a 10-HP. Hornsby-Akroyd oil engine, which drives an Ingersoll-Sergeant Class E air compressor. The oil engine occupies a floor space of 9 ft. 2 ins. × 5 ft. The air compressor has a base measuring 6 ft. × 2 ft. 1 in., and is capable of furnishing 107 cu. ft. of free air per minute at 150 revolutions. The air is compressed and delivered to a receiver at 50 lbs. pressure. It is then carried to another receiver about 200 ft. distant. Midway on the pipe line a reducing valve regulates the pressure and admits it to the second receiver at 30 lbs. pressure. This receiver holds the immediate supply of air to operate the trumpet.

Exhausting through the siren at this lower pressure enables the receiver to maintain the supply after a fog rises for a time sufficient to get the engine and compressor in operation. There are two trumpets attached to the receiver, which are used together or alternately, as desired. A first-class siren is supposed to consume 12 cu. ft. of free air per second.

The siren is sounded automatically, and blows at intervals of 30 to 50 seconds. As a musical instrument it can be best described by calling it a big clarionet.

The Daboll trumpet is another fog signal similar in general design, but having a smaller range of audibility, and requiring less power. The plant used consists of a 4-HP. engine and a vertical belt-driven compressor furnishing 17 to 20 cu. ft. of free air per minute. It delivers air at a pressure of 5 to 10 lbs. to a receiver which supplies the trumpet.

The Third Lighthouse District in which these plants are being installed, extends from Rhode Island to Sandy Hook, with headquarters at Tompkinsville, Staten Island. It is under the charge of Col. D. P. Heap, Corps of Engineers, U. S. A., and the mechanical signals are under the direction of Mr. C. Lamy. We are indebted to the Ingersoll-Sergeant Co. for the information from which the above article is prepared.

PHOSPHORUS MATCHES, says a writer in the Boston "Transcript," were first introduced on a commercial scale in 1833, and the first U. S. patent for friction matches was issued in 1836. The present "safety" match was invented by a Swede, named Lundstrom, in 1855. The so-called "parlor" match was invented in 1848 and originated with the manufacture of Schrotter's amorphous phosphorus, which is odorless and tasteless, is not poisonous and does not take fire at ordinary temperature. The first practical friction match was invented, in 1827, by Mr. Walker, an English apothecary. He coated slips of cardboard with sulphur and tipped them with a combination of antimony, chlorate of potash and gum. These matches were sold in a box of 84 for one cent and a piece of glass-paper was provided to rub them upon.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

We publish on another page a detailed description of the methods employed in transporting and erecting a plate girder highway bridge, which we would commend to our younger readers especially, not only for its practical value but because it is an excellent illustration of a prominent feature in the experience of most successful engineers, viz.: the ability to make the very best use of the materials at hand. Many a man can do good work with good tools, but the real test of his ability is in doing good work with poor tools. The engineer who is not fertile in expedients may have his uses in a subordinate position; but when he is sent away from headquarters and thrown upon his own resources, he will be apt to "get in a hole" very soon.

In the article referred to it is an exceedingly interesting study to follow the work in its course from the shop to the completed bridge and see how every difficulty in handling it was met and overcome by very simple but effective methods. To raise the girders for loading on the cars, the weight of 40 tons was lifted by 3-ton air hoists, where a duller engineer would have first fumed over the lack of an overhead crane and next proceeded to laboriously lift the girders the full height by hand jacks. The method of transporting and handling the girders, by which a light hoisting engine handled each pair of girders from the time they left the car until they rested on their piers, is worthy of especial commendation, and we doubt not could be adopted with great advantage by many engineers in charge of similar work.

The symposium of modern practice in turntable construction, which is concluded in this issue, is suggestive of several interesting lessons to railway engineers. In the early days of railways, and indeed up to a time not very long passed, turntables of wood or of a combination of wood and iron served all purposes with the light locomotives then in use. Their lives were indeed short, only from five to eight years, but on the other hand they were not very expensive in first cost nor in renewal. The turntable of the present day is quite a different structure. Like all other permanent way and track structures it has undergone modifications in design and construction to suit the increased size and weight of the rolling stock which modern traffic demands. We find consequently that correspondingly greater attention is being given by railway engineers to the careful study of structural principles and construction details in all parts of turntable structures. It is in their forcible illustration of this fact that the designs described in the article referred to above furnish their first valuable lesson to engineers. Only a very cursory examination is necessary to show that in points of material, weight, rigidity and careful design and workmanship the most modern examples of turntables take a position subordinate to no class of railway permanent way structures. That this is as it should be goes almost without saying, when the conditions of their service are considered; but nevertheless the point is deserving of emphasis at this time. It is no very long period since the turntable of 100-ton and 150-ton capacity has been demanded and in the stress of hard times which the last few years have dealt out to railways as well as to other business interests the demand has been met in many instances by temporary methods, generally by making the old structure serve as best it could with perhaps a little strengthening. Such temporary expedients must in the nature of things come to an end some time, and as a general thing the end will be as soon as the money is in any way available for improved structures.

With the advent of the riveted steel and iron turntable, however, the question of maintenance assumes an importance which it did not have with the older wooden or cast iron table. Particularly is this true in respect to corrosion. Like other permanent way structures of metal, the turntable is subjected to the destructive influences of natural agencies, as well as to the wear and tear of traffic. Snow and rain, the drippings from locomotives and to a certain extent gaseous products of burning coal all conspire to its ultimate destruction, and must be fought against to secure the greatest durability. As a concrete example of this necessity the experience quoted on the Louisville, New Albany & Chicago Ry., whose practice in turntable construction is described in the article under discussion, is exceedingly instructive. Precautions at least equal to such as are taken to preserve a plate girder bridge can and should be employed with the turntable, yet it is no uncommon thing to find them neglected in a far greater measure. To preserve a metal bridge it is thoroughly painted upon erection and repainted periodically as occasion demands, periodical inspection and minor repairs are made, and thorough drainage insisted upon. It needs no argument to show that the same precautions are at least equally needed and equally important to preserve the metal turntable.

Another point brought out by the article which is interesting to note is the comparative cost of metal and wooden turntables. The 66.6 ft. wooden truss drum-bearing turntable of the New York, New Haven & Hartford R. R., built for heavy locomotives, costs about $1,400, while the wrought iron riveted plate girder deck table 70 ft. long, built by the Pennsylvania R. R. Co., costs about $1,300. For the modern 100 to 150-ton locomotive and tender load it would appear that little or no saving in first cost is to be obtained by using wood instead of metal for turntables. Many other interesting points of comparison will be developed by a study of our descriptions and drawings which need not be mentioned here.

A cash offer of $5,000 for a sewerage franchise in Mobile, Ala., has been made by Mr. C. W. Stanton. Although Mobile had a population of over 30,000 in 1890, it is still practically without a sewerage system. Before attempting to secure sewers by granting a franchise to a private party, the city might with profit ascertain the experience of the few municipalities that have entrusted this important matter to private companies. While few cities have tried this experiment, their experience has, as a rule, been most unfavorable to this plan.

In our issue of March 25, on our page of "Engineering News Notes," we printed an item from an Omaha, Nebraska, daily paper concerning an alleged breakdown of two large Westinghouse engines in an electric railway power house in that city. Later information from the Superintendent and Chief Engineer of the Omaha & Council Bluffs Railway and Bridge Co. is to the effect that the accident referred to was a trivial matter, which was greatly exaggerated in the newspaper account which we copied, and caused no such damage or interruption to the station service as was claimed. We sincerely regret that publicity should have been given to the misleading statement in our columns, and tender our apologies to the parties concerned.

PRESENT TENDENCIES IN WATER-WORKS PRACTICE.

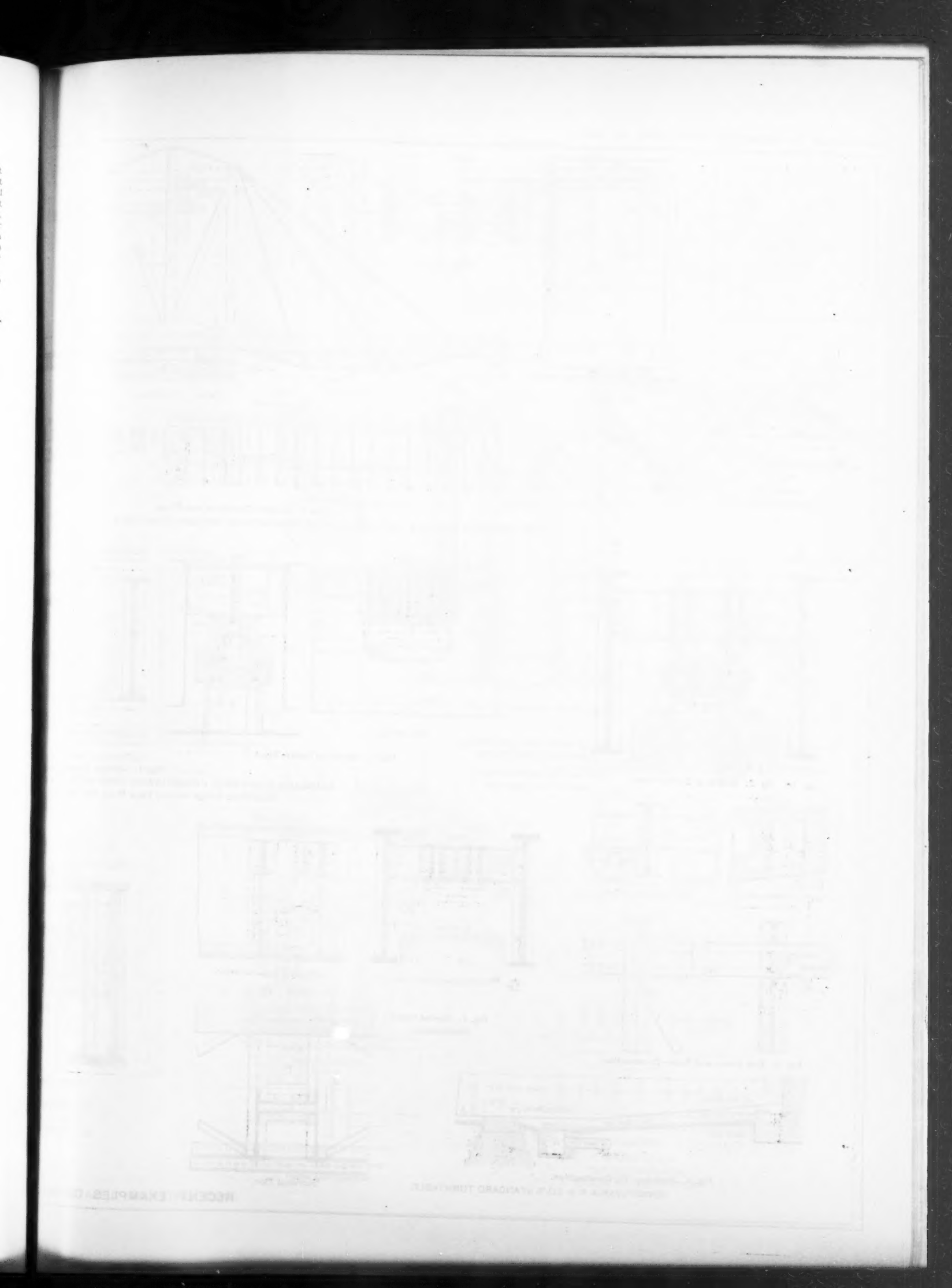
The completion of the "Manual of American Water-Works" for 1897 enables us to present to our readers some interesting facts respecting present tendencies in water-works practice. These conclusions are based upon descriptions of about 3,350 water-works in the United States and Canada, more than 1,200 of which have been built since the compilation of the "Manual" for 1890-1.

Of absolutely new things in water-works practice since the publication of our last "Manual," the air-lift pump stands first. Five years ago, it is probably safe to say, not a water-works superintendent had even heard of the theory of the air-lift pump, while to-day the device is in use in several scores of cities. It has come rapidly into use because of its simplicity as a means of raising water from deep wells, and is popular because it affords so ready a means of increasing the yield of wells that have begun to decrease in capacity.

Next to the air-lift pump as a unique thing in raising water comes the gasoline engine, driving some simple form of pump. This, too, is often used for deep wells, but the feature which has brought it so rapidly into use is its extreme simplicity in operation, requiring, in the case of small plants, no constant attendant. This feature, combined with its low first cost and the ease and economy with which it may be started and stopped, has made water-works a possibility and a fact in a great many small Western towns in the past five years. In the Eastern part of the country it has not been employed so much, because the need of a public water supply is not so imperative in small villages as in places of similar size on the Western plains, and when needed the demand may more often be met by small gravity supplies from hillside springs or mountain streams.

The electric motor as a means of driving pumping machinery has a most promising future. A number of such motors are now furnished with current from electric lighting or power plants. There are many pumping stations located at points quite distant from any railway, involving, where steam is used, long wagon hauls for the coal. Some of these are outside the town and others are high service stations, supplying limited sections of a city. In either case it would often be more advantageous to convey current than coal to the pumps. There seems to be a special field for electric pumps for high service supplies, although gasoline engines might be preferable where the areas or populations are limited. In many pumping systems the whole of a hilly town is on one pumping service, necessitating a needlessly high head on the pumps in order to supply the higher levels. Often this might be obviated, or water provided for some section without a supply, by having a high service, but the cost of a separate supply main or pumping station seems prohibitory. Electric or gasoline driven pumps might solve the problem, either saving expense in pumping or making some beautiful but elevated residence section more inviting to home seekers.

Notwithstanding the development of electric and gasoline power for pumping, the time-honored windmill still retains a place in connection with public water supplies. To be sure, it is dependent upon the vagaries of the wind, but where the principal object of the water-works is to keep a small tank filled for fire protection, the windmill does excellent service. The modern windmill is wonderfully cheap in construction, requires very little attention, and when supplemented by some more reliable power for use in calms, the combination will lift water for a small village at a remarkably low cost. A gasoline engine would make a good running mate for a windmill, although in appearance



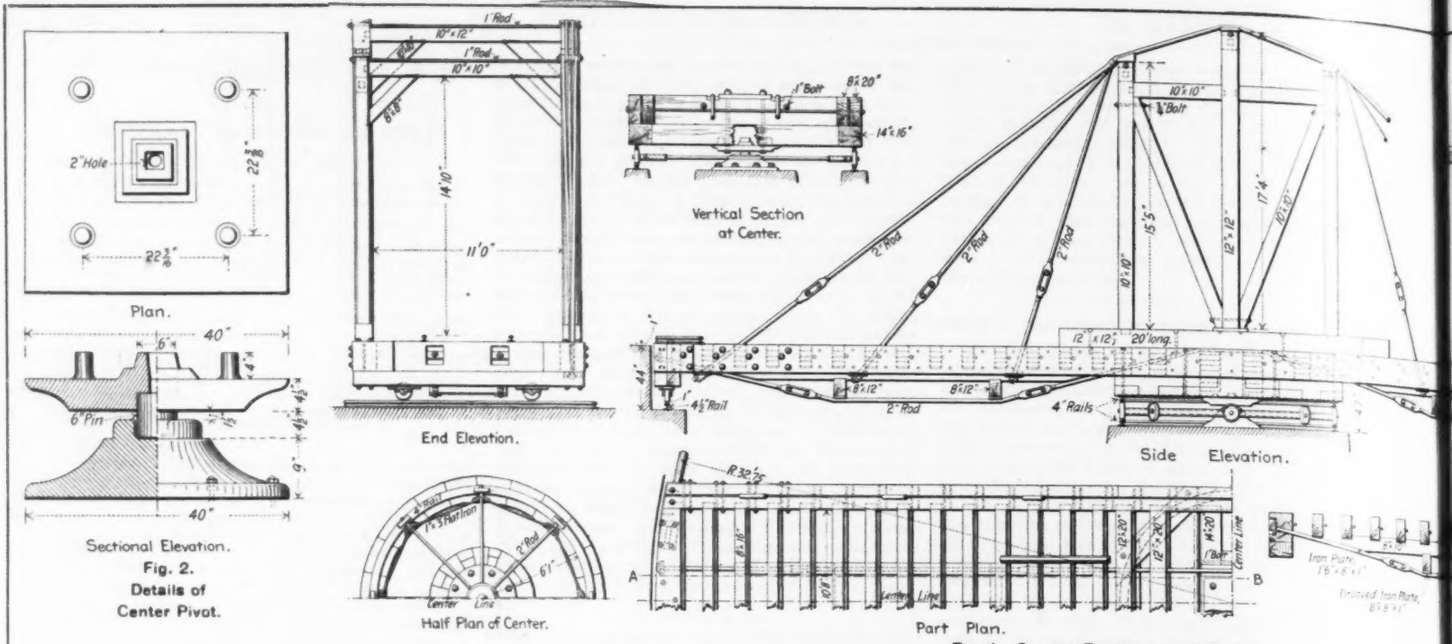


Fig. 2. Details of Center Pivot.

Fig. 1. General Elevations and Plans.

NEW YORK NEW HAVEN & HARTFORD R. R. CO.'S OVER-TRUSS WOODEN TURNTABLE.

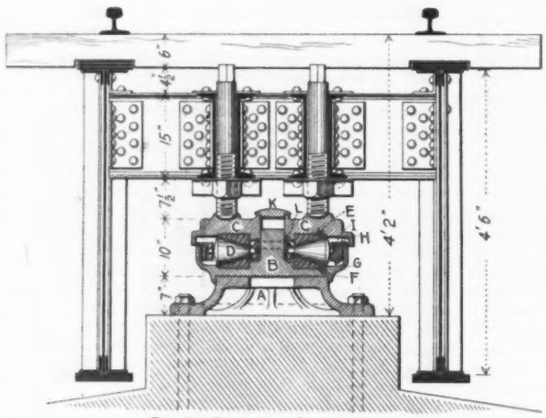


Fig. 2. Details of Center Pivot.

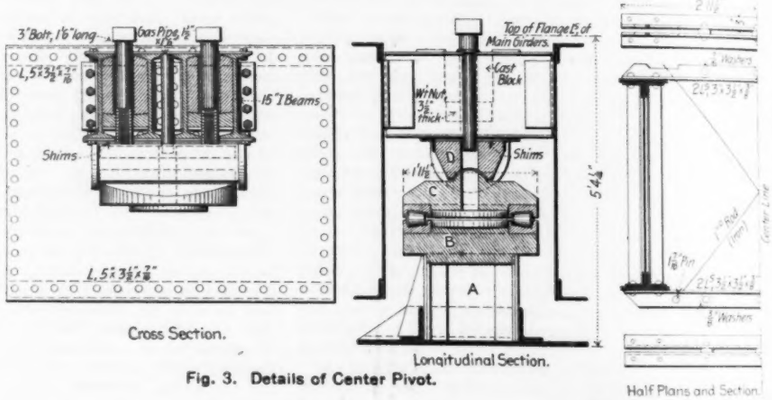
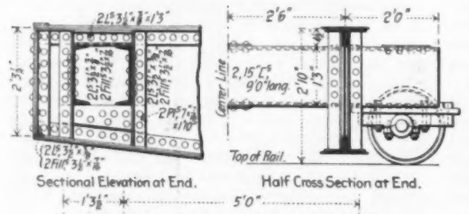


Fig. 3. Details of Center Pivot.

Fig. 1. Vertical Cross Bracing.

STANDARD TURNTABLE, PENNSYLVANIA LINES WEST OF PITT[illegible]BUR[illegible]

Edge Moor Bridge Works, Edge Moor, Del., Builders.



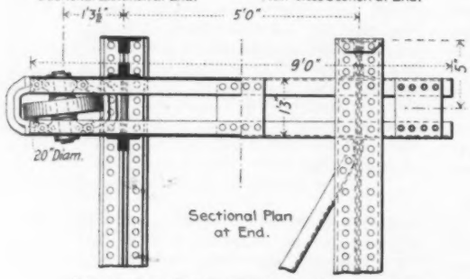


Fig. 3. End Girder and Roller Construction.

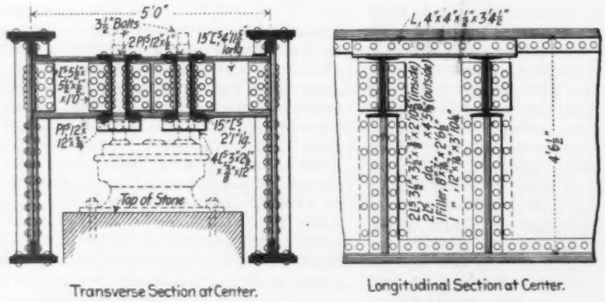


Fig. 1. Center Girder Construction.

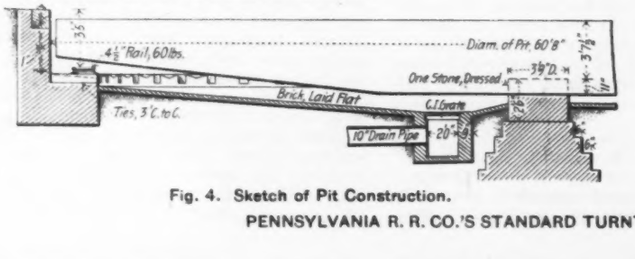
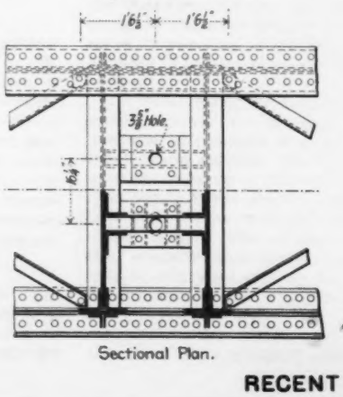
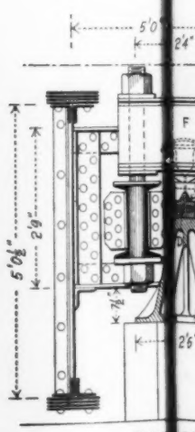


Fig. 4. Sketch of Pit Construction.

PENNSYLVANIA R. R. CO.'S STANDARD TURNTABLE.





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RECENT EXAMPLES OF RAILWAY

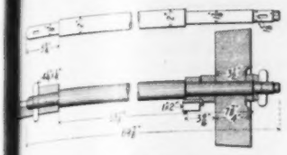
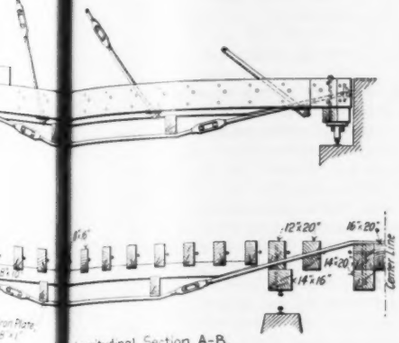
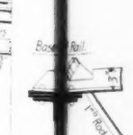


Fig. 3. Details of Center Bearing Rollers.



Longitudinal Section A-B.



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OF PITTSBURG.
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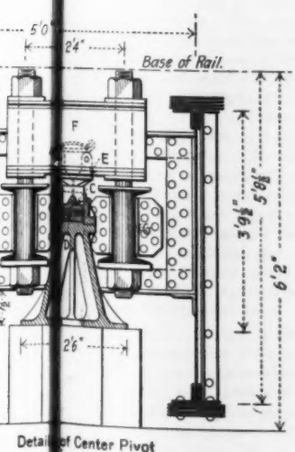
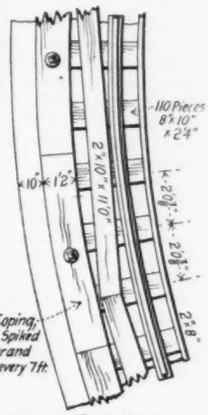
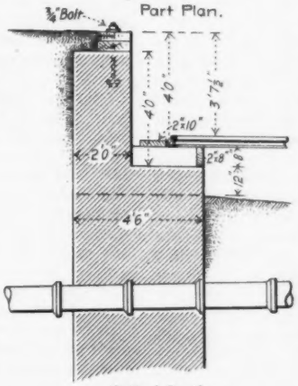


Detail of Center Pivot

PENCOYD IRON WORKS
PENCOYD, PA.,
STANDARD TURNTABLE.



Part Plan.



Vertical Section.

Fig. 5.
Pit Wall and
Track Construction.

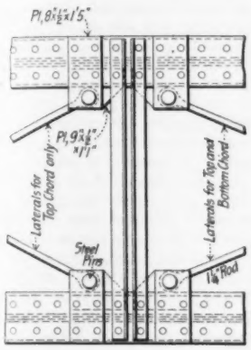
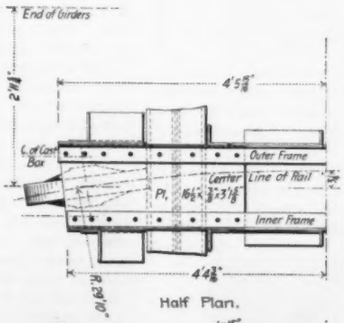
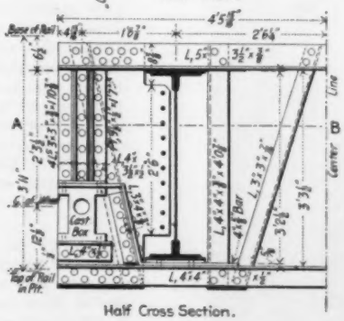


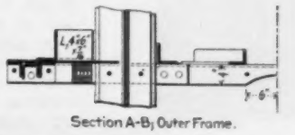
Fig. 2. Lateral Bracing.



Half Plan.



Half Cross Section.



Section A-B, Outer Frame.

Fig. 4. End Girder and
Roller Construction.

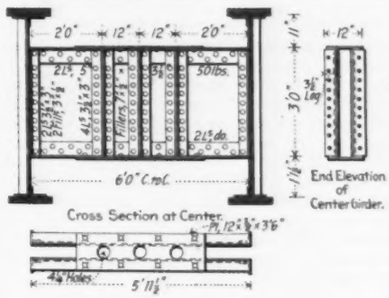
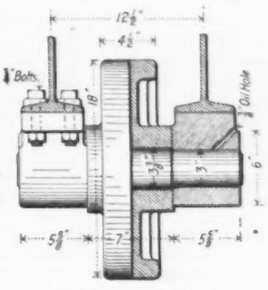


Fig. 2. Center Girder
Construction.



Half Elevation. Half Section.

Fig. 4. Details of
End Roller.

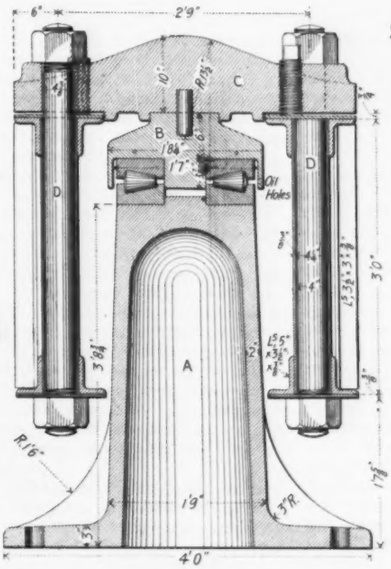
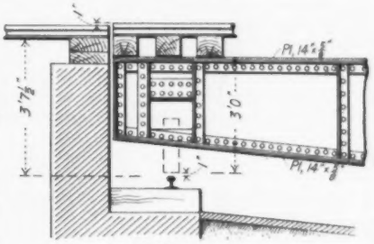


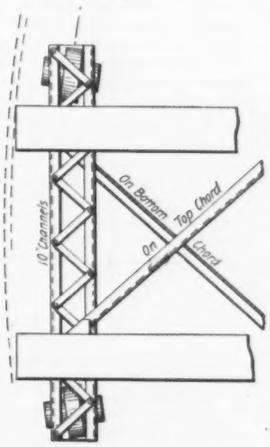
Fig. 1. Details of Center Pivot.

NORFOLK & WESTERN RY. CO.'S
STANDARD TURNTABLE.

Virginia Bridge and Iron Co.,
Roanoke, Va., Builders.

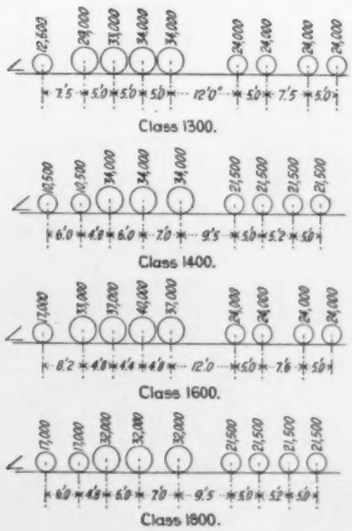


Vertical Section.



Part Plan.

Fig. 3. End Girder
and Roller Construction.



WHEEL LOADS
OF LOCOMOTIVES,
UNION PACIFIC SYSTEM.

RAILWAY TURNTABLE CONSTRUCTION.

the pair might seem decidedly ill-matched. In several instances noted in the "Manual," economy in construction is effected by placing the windmill on top of the tank to which water is pumped. The trestle supporting the tank might be enclosed to house a supplementary pump, when one is provided.

Passing now from small to large pumping plants, the increasing use of pumps with very high duties may be noted. It is true that a few pumps of comparatively high duty were in operation prior to 1880, notably the Corliss pumping engines at Pawtucket. In the last few years a specification now and then has called for a duty of 140,000,000 ft. lbs., or even higher.

A few years ago it looked as though crude oil might, especially under favorable local conditions, be adopted much more generally than it has been as fuel for water-works boilers, but there have been few if any notable additions to the list of places using oil. Of large cities, Detroit still uses oil, but no other important city can be recalled where oil is in use, although a number of similar cities still use it.

In the introduction to the "Manual" for 1890-1 some figures were brought together, showing very conclusively that the cities having low water consumption per capita had, quite generally, a large percentage of their taps metered, and also that high consumption commonly prevailed where the contrary was true. Great care has been taken to ascertain for the 1897 "Manual" the general conditions governing the use of meters, as well as the extent of their use. It appears from the reports received that the meter is growing in favor, both with water officials and consumers. Some cities and private companies still restrict the use of meters by requiring large deposits or rentals for their use and high rates for the water consumed, but others go so far contrary as to provide meters without cost to the consumer, at the same time making a low price for the water passing through them. Quite a number of works, including some small ones, have adopted the full meter system of late, and many others are moving as rapidly as possible in that direction. The initial step is generally the metering of a few of the largest consumers, proceeding from this to the general adoption of meters, for all but domestic consumers, and making meters possible, even for these and other small water takers. There seems to be a common agreement among water-works officials that whoever may own the meter, it is essential that the water department should control it, and also that it is not the liberal use, but the absolutely useless waste of water that is being fought, and which meters operate to check.

One of the most revolutionary changes in water-works construction within the past five years has been the use of riveted steel pipe for conduits of large sizes. The pioneer in this line, the Newark supply main, 48 ins. in diameter and 21 miles long, was put in use in 1892. Since then other notable steel conduits have been constructed for the water supplies of Rochester, Allegheny, Cambridge, Portland, Ore., Vancouver, B. C., and a large steel intake has been laid on the bed of Lake Skaneateles in connection with the Syracuse water-works. Improved preservative coatings for steel pipe are aiding greatly in inspiring confidence in its durability.

Wood stave pipes continue in favor in the West, but its use has not extended east of the Mississippi River, at least for conduits of any length. In rough country wood stave conduits surpass steel in ease of transportation as much as it, in turn, surpasses cast iron.

In the design of elevated tanks, curved bottoms have recently been used in a number of instances, and steel supporting towers or trestles are now commonly employed. The elevated tank is now preferred by many engineers to the stand-pipe, it being recognized that in many instances the effective upper 20 or 30 ft. of water can be supported more cheaply, and perhaps safely, by a trestle than by a body of water enclosed in a cylinder. Where high hills are available for sites, and storage is quite as important as pressure, stand-pipes have advantages of their own. The elevated tank is most used in the West, in connection with small water-works systems, where from 30,000 to 60,000 gallons of water stored at a moderate elevation, a well, a small pumping station, a few thousand feet of mains and a few hydrants constitute the water supply for hundreds of small communities. The cost of such a small water-works system is often as low as $5,000 to $6,000, and the benefits to the health and comfort of the community and its advantage as a protection from fire make it a most potent factor in increasing the comfort and attractiveness of village life.

Five years has seen a wonderful increase in the popular demand for pure water. This has been secured in many instances by providing entirely new and naturally satisfactory sources of supply, and in others by some method of water purification. Mechanical filters were introduced some 10 to 15 years ago, and slow sand filtration has been in use at a few places in this country for many years. But within the past five to seven years each process has been coming rapidly to the front, until in the present "Manual" over 100 mechanical filtration plants are listed, and perhaps 10 or 12 filter-bed systems operated in accordance with the recent flood of light on the subject. Slow sand filtration has been gradually gaining in favor, as the result of disinterested scientific investigation. Mechanical filters have been adopted at scores of places to remove such manifest impurities as silt, color, vegetable matter, odor and iron, aeration commonly supplementing filtration where odor or iron are to be removed. Such impurities as these appeal so powerfully to the senses that the people rise up in veritable wrath and demand their removal. Equally strong insistance on the removal of unseen, but infinitely more dangerous, organic impurities comes more slowly, but is making itself felt none the less surely in many communities. Chemistry, bacteriology and good common sense are aiding mightily in placing impure water supplies in their true light before the public, and in indicating how their use may be rendered unnecessary.

While much is claimed for the bacterial efficiency of mechanical filters, the fact remains that the claims are not yet so firmly verified by scientific research as are those of slow sand filtration. The elaborate experiments at Providence tend to greatly increase confidence in the bacterial efficiency of the process, and all interested in the subject are eagerly awaiting the results of the yet more exhaustive Louisville experiments, on a water of an altogether different character, carried on with a variety of makes of filters, all sufficiently large to make them, in point of size, comparable with filters in regular use. There is no doubt but what both mechanical and slow sand filtration have a great future in this country, and that with the aid of one or the other, pure water for all is a possibility.

There are indications that sedimentation will come into still more general use for waters carrying silt. Large settling basins have been built within a few years at St. Louis and Omaha, and some have long been in use elsewhere. Filter beds for St. Louis were recommended 30 years ago by the late Jas. Kirkwood, in an elaborate report, which, for a quarter of a century, was about the only available treatise in English on the subject of filtration. Mr. Kirkwood considered settling basins an essential accompaniment of filtration, and they were built, although the filters were not.

Larger settling basins have been constructed since in connection with the new source of supply, higher up the Mississippi River, and the addition of filters is now under consideration. Besides Providence, Louisville and St. Louis, at each of which places filters will doubtless be installed within a few years, Cincinnati and Minneapolis are practically committed to filtration, and Philadelphia, Pittsburg and Albany may soon follow. Other cities, great and small, are also rapidly coming into line, so that in ten years we may expect to see pure water and low typhoid death rates in many places where the contrary now prevail.

In closing this review of some of the most notable tendencies in water-works practice, a word should be said regarding the beneficial effect upon these undertakings which must result from the recent interest taken in the reform of municipal government. While many a familiar name still on the list of official attests the fact that in many cities a faithful and efficient water-works superintendent or secretary is appreciated, there are more changes than can be accounted for merely by natural causes or renewals for the good of the service alone. If any public servant becomes valuable with increased years and experience, it is the man responsible for the operation of a water-works plant. It is certainly to be hoped that with better municipal government there may come a change in the policy which is still followed in too many cities of making a change in the water supply department heads with every change in the dominant faction in municipal politics; and that instead we may everywhere see the man who discharges his duties faithfully and well retained in his position year after year, so long as his meritorious service continues.

LETTERS TO THE EDITOR.

A Bridge Wreck from an Unusual Cause.

Sir: I send herewith a photograph of the wreck of a country highway bridge at Rochester, Pa. During a wind storm last month a large oak tree which stood at the east end of the bridge was blown down and one of the large limbs, 8 ins. in diameter, struck the bridge on the top chord and knocked the structure into the gorge below. The bridge was about 100 ft. span and its floor was about

A HIGHWAY BRIDGE WRECKED BY A FALLING TREE.

(The tree whose fall caused the accident is seen at the left. The branch which struck the top chord and caused the fall of the bridge is seen near the bottom of the gorge just beyond where the men are standing.)

40 ft. above the stream. The bridge was constructed several yearn ago by the Penn Bridge Co., of Beaver Falls, Pa., and has stood some very heavy loads. I have no doubt there are many bridges throughout the country which are in danger of being wrecked by falling trees.

Very respectfully, J. P. Leaf.

Rochester, Pa., April 8, 1897.

Telephoning to a Diver.

Sir: An item on p. 224 of the current issue of Engineering News gravely announces that "Telephoning to a submarine diver is a recent electrical achievement." The date given (April 1) on which the experiment was tried would naturally suggest the idea that some one had been imposing on your credulity. We might be disposed to think that it was a waif from your "Chapter of Curiosities" were it not that Engineering News of June 6, 1878, contains a letter from Mr. Francis D. Fisher, M. Am. Soc. C. E., describing his use of the telephone while making some "submarine examinations in Boston harbor," extending over a period of several days. Mr. John A. Webster, of Boston, is credited with being the first diver to use the device, the details being worked out by Mr. Thomas A. Watson, Supt. of the Bell Telephone Co.

Very truly youre, John C. Chase.

Wilmington, N. C., April 9, 1897.

Concerning Disagreeable Effect on Railway Curves.

Sir: While it is perhaps an unimportant point to discuss, I wish to point out that in the discussion of the error in Mr. Wellington's "Economic Theory of Railway Location," given in your issue of April 1, there appears to be an erroneous opinion in the mind of the critic.

I am not sure that I understand him clearly, but if I do, he assumes that the car body is going to tip outward by the action of what is commonly called centrifugal force. I have pointed out in a recent article in "The Polytechnic"—abstracted (but not as to this point) in Engineering News of March 25, that if the track is properly elevated for a given speed, the car floor should remain parallel to the track at that speed. For any less speed there would be a tipping toward the centre, for any greater speed a tipping toward the outside. The reason of this is that the correct elevation of track is that which makes the track normal to the resultant of the weight of the car and the so-called centrifugal force. Since these two forces act through the centre of gravity of the car, their resultant is normal to the floor at its middle point and hence there are equal pressures on the springs. These pressures are greater than on a tangent, as was pointed out in the article already mentioned.

The limiting speed for comfortable riding is not that speed that brings the car body level, but is that speed beyond which there will be a tendency to tip outward, i. e. it is the speed for which the track is canted. In the article already mentioned were given equations for the limiting speeds for any maximum cant of track; and a table of such speeds for various degree curves and cant limits of 6 ins., 9 ins. and 12 ins., was also given. As this was not printed in the abstract in Engineering News I append it, thinking it may be of interest to some enginemen.

Limit of Speed for Comfortable Riding. (Nearest Mile.)

Cant, ins.	Degree of Curve. 1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	24	30	40
6	..	93	66	54	47	42	38	35	33	31	30	28	27	25	23	22	21	19	17	15
9	..	115	81	66	57	51	47	43	41	38	36	35	33	31	29	27	26	23	21	18
12	..	132	93	76	66	59	54	50	47	44	42	40	38	35	33	31	30	27	24	21

I may say that Mr. Wellington was fully cognizant of the error mentioned by Mr. Taylor, and intended to correct it, together with some others, in future editions of his book.

Very truly, Wm. G. Raymond.

Rensselaer Polytechnic Institute,
Troy, N. Y., April 9, 1897.

(Prof. Raymond, in another letter, also says that the supposed misprint in the paper on track elevation, giving 4.9 ft. instead of 4.7 ft. for gage, is not a misprint at all. The 4.9 ft. is an assumed value for gage plus one rail-head, or the distance between rail centers. He considers this a more correct quantity to use than the gage.—Ed.)

Water Power Development at St. Mary's Falls; Most Efficient Slope for Canal.

Sir: The letter in your issue of Feb. 25, referring to water-power development at St. Mary's Falls, Michigan, suggested to me a rather interesting problem, namely, the determination in a given case of the most efficient slope for a canal supplying water for power purposes:

Let H = total fall from head of canal to tail race in feet.
h = total head used up in canal in feet.
l = total length of canal in feet.
W = weight of water in pounds per cubic foot.
P = gross horse power of the created water fall.
Q = A V = AC $\sqrt{rs}$ = discharge of canal in cubic feet per second.

Then,

$$P = \frac{Q\,W\,(H-h)}{550} = \frac{W}{550} A\,C\,\sqrt{rs}\,(H-h),$$

but since

$$s = \frac{h}{l},$$

therefore,

$$P = \frac{W}{550} A\,C\,\sqrt{\frac{r}{l}}\,\sqrt{h}\,(H-h).$$

Assume that the cross section of the canal has been fixed, then r, the hydraulic radius, and A, the area, will be constants. Assume for an approximate solution that C is constant for different slopes, then since W and l are also constants, we may place,

$$\frac{W}{550} A\,C\sqrt{\frac{r}{l}} = K,$$

a constant, and write the last equation,

$$P = K\,(H\,h^{\frac{1}{2}} - h^{\frac{3}{2}})$$

To get a maximum value for P, place its first derivative with respect to h equal to zero, and solve for h, bearing in mind that H is a constant. This gives,

$$\frac{dP}{dh} = K\left(\frac{H}{2h^{\frac{1}{2}}} - \frac{3}{2}h^{\frac{1}{2}}\right) = 0.$$

Whence,

$$\frac{H}{2h^{\frac{1}{2}}} = \frac{3}{2}h^{\frac{1}{2}} \text{ or } h = \frac{1}{3}H.$$

Applying this solution to the case of St. Mary's Falls gives h = 6 ft. and H − h = 12 ft. Calling the length of canal (given as 3 miles) 16,000 ft., this gives a slope of .000375.

The curve Fig. 2 is the result of another and more exact method of solving this special case, taking account of the variation of C with that of S. In this solution the values of C are obtained with Kutter's formula using n = 0.03. This is practically the same value for n as was obtained from discharge measurements of the Des Plaines River diversion channel, taken by the Sanitary District of Chicago and described by Mr. W. T. Keating in a paper read before the Western Society of Engineers in April, 1896. This diversion channel is 200 ft. wide on the bottom and the measurements were taken with the depth ranging from 5 ft. to 10 ft. I think it safe to assume that the water power canal under consideration would offer no more resistance to flow than the Des Plaines river diversion channel.

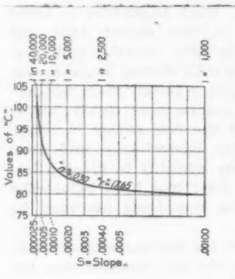


Fig. 1.

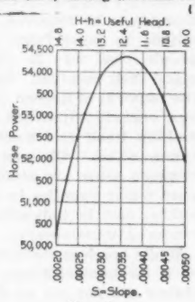


Fig. 2.

The proposed dimensions of the St. Mary's Falls canal are given as follows: Width, 300 ft.; depth, 20 ft. (giving r = 17.65 and A = 6,000); length, 3 miles (I used 16,000 ft.), and total fall of H equal to 18 ft. The curve, Fig. 1, shows the relation of C to S for the given case. From curve, Fig. 2, it is seen that the maximum horse power of the water fall is developed by using a slope almost the same as that obtained by the first solution. If the section of this canal were 200 ft. × 30 ft. instead of 300 ft. × 20 ft., the gross horse power would be about 20% greater.

Yours truly, H. P. Boardman.

Chicago, March 22, 1897.

(In our issue of May 4, 1893, Messrs. Arthur L. Adams and R. G. Gemmel presented a calculation similar to the one given by Mr. Boardman, but for the case of long pipes instead of canals, and they reached an identical result, viz.: that maximum power for a given pipe is obtained when the frictional loss equals one-third of the total head.—Ed.)

More Engineering Curiosities.

Sir: In reading through your interesting editorials, which you call "Chapters of Curiosities," I am reminded of a great "invention" which was brought to my attention some years ago. The man who originated it is still alive and has made several efforts in late years to float a company to carry his scheme through. I do not wish to mention his name, but I think any one who has ever heard, or will ever hear, of the proposed apparatus will recognize him without difficulty.

The object of the invention was to do away with the present cumbersome and wasteful process of making steel by smelting the ore in the blast furnace and then blowing in a converter. It was a direct process. The gentleman is a "chemist" of pronounced views. He calculated that, since iron ore was simply a combination of oxygen and iron, with a few impurities, if he could supply a substance which would immediately take up this oxygen and leave the iron free, he then would have metallic iron in an extremely fine state. To his comprehensive mind there was only one element which could be considered satisfactory, and that was hydrogen. To produce this in large enough quantities was a matter of considerable expense, but here his great ability again showed itself. Water, he knew, was a mixture of oxygen and hydrogen. He was also aware that water could be decomposed by electricity, the oxygen separating at one pole and the hydrogen at the other. Of course the expense of generating the electricity must be allowed for, but, with an ingenuity that few engineers have at their command, he calculated that if his plant was put in a large city he could use what he called "waste" electricity.

He explained this to me as follows:

You know that when a dynamo is revolving it sends a current out of one wire and pushes it into all the electric lamps on the circuit. Now, after it has gone through these lamps it has to come back over the other wire without doing any work. Now, what I propose doing is, right in the middle of this return wire to make a break, dipping both ends of the wire in water, decomposing the water with the waste current and fully utilizing the product of the dynamo.

You will see that this is a marvel of simplicity. The process hardly needs further explanation. The hydrogen that he would generate from this water was to be burned in a retort or chamber in which the finely powdered iron ore was to be sprayed. The chamber was to be kept at a bright red heat, and naturally the oxygen in the iron ore would immediately leave it and go off with the hydrogen that was injected. Finely powdered metallic iron, with an exceedingly small proportion, as he put it, of impurities, was to be drawn off into a hermetically sealed crucible, and this was to be brought to a melting heat by means of a oxy-hydrogen blow-pipe, using a mixture of the gases resulting from the decomposition of the water.

This gentleman "discovered" also that the only substance which had any real, earnest effect in changing iron to steel was cyanogen. Therefore, at the same time that the hydrogen was blown in a retort, there was to be a gentle stream of carbonic oxide gas (CO) going in with it. He figured that a reaction would take place by which CN would be formed, and this would give him a marvellous metal.

This gentleman is exceedingly plausible, and, absurd as his theory seemed, he has been able to convince quite a number of men of his ability to carry it into practice, and has collected from some of them, from time to time, large sums of money, with which he has erected an experimental plant. No practical results ever came from this plant, as you may imagine. The additional calls for money were always for the purpose of making more "improvements."

I have also in my little "Chapter of Curiosities" a brief note of a man who was going to provide a mine ventilating fan without using any coal to produce power. His scheme, which was tried once in a rather gassy mine in the South, was to keep the mixture of gas and air in the return airway just within the explosive limits. By means of a series of small chambers just in front of the fan this mixture was to be exploded and the pressure caused by the explosion was to furnish power for the fan. The only experiment that he tried killed two men, injured three others, completely wrecked the fan and fan-house and caused considerable damage in the mine. I haven't heard of its repetition.

In my career as an engineer I have run across a good many curious things of this kind. It seems that no matter how absurd a project may be devised by a scatter-brained inventor, if he can present it in a plausible manner, he almost invariably will find some one as great a fool as himself ready to put some money in it. It would be a good thing for the profession at large if all engineers would lay before the public, through your paper, any project of this kind that come before them. If one-tenth of the money that has been wasted in imposible "inventions" had been invested in worthy ones, I think that the sciences would have advanced much beyond their present standing.

Yours very truly, H. S. Fleming, M. E.

176 Broadway, New York city, April 9. 1897.

Transition Curves.

Sir: All curves of more than 2° are supplied with a spiral on each end and take up 7° of the whole angle, or 3° 30′ each, and are laid out by the following six deflection angles, locating six chords whose length = $\frac{100}{D}$; where D = the degree of the main curve, and the length of spiral = $\frac{600}{D}$:

Deflection Angles.

From tangent end:

0° 05′ 0° 12½′ 0° 23½′ 0°37½′ 0° 55′ 1° 16′

From curve end:

0° 30′ 0° 57½′ 1° 22′ 1° 42½′ 2° 00′ 2° 14′

In practice 1° 16′ and 2° 14′, are the only ones used on location.

Ordinary circular curve tables for 1° curves may be

used by adding 250 to quantities found in the tangent column, and by adding 2.5 to quantities found in the secant column.

Subtangents for individual spirals are $\frac{383}{D}$ and $\frac{217}{D}$; and ordinates or offsets from tangent to the six-chord points equal:

$$\frac{0.14}{D} \quad \frac{.73}{D} \quad \frac{2.00}{D} \quad \frac{4.40}{D} \quad \frac{8.00}{D} \quad \frac{13.3}{D}$$

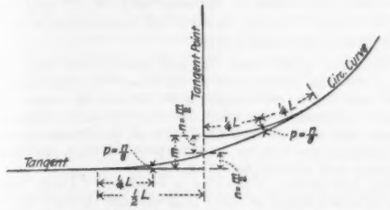
For further particulars and for extraordinary accuracy see Engineering News, Jan. 14, 1894, or "Journal of Association of Engineers' Societies," Dec., 1894.

A Subscriber.

Tupper Lake, N. Y., Jan. 1, 1897.

Sir: The method of laying out transition curves given by Mr. David Molitor in your issue of Feb. 4, 1897, admits of much more flexibility than would be inferred from the formulas and table given.

The length and offset may be chosen within wide limits to suit the location and degree of easement desired. It is often desired to shift a curve or tangent slightly so as to pass through a given point, and this may be done by varying the offsets without disturbing the remainder of the line, as it is a matter of indifference so far as the transition curve is concerned whether the curve is set in or the tangent set out or both.



The following easily memorized values are deduced from the formulas given and give all the data needed without reference to a table:

If D = degree of curve, then;

Length of transition curve = L = 30 D (nearly).

Offset from tangent to circular curve at tangent point

$$= m = \tfrac{2}{3} \frac{D^2}{100} \text{ (nearly)}.$$

Offset from tangent or circular curve to transition curve at tangent point $= n = \frac{m}{2}$.

Offset from tangent or circular curve to transition curve at quarter points $= p = \frac{n}{8}$.

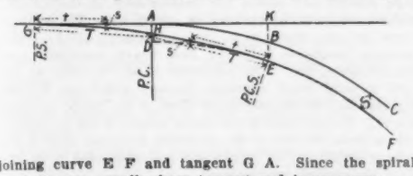
Yours very truly, O. E. Selby,

Res. Engr., Louisville & Jeffersonville Bridge Co.

Louisville, Ky., Feb. 8, 1897.

Sir: I have found the following method of laying out spiral curves very convenient, especially in putting spirals in track already laid without easement, as the application of the formula begins by assuming what is usually the determining factor in such cases, viz., the distance the circular curve is moved inward for easement.

Let A B C be the curve to be tapered, D E F the parallel curve, set in a given distance, S, and G H E the spiral



joining curve E F and tangent G A. Since the spiral must diverge equally from tangent and inner curve:

$$G\,H = H\,E = T$$

$$\text{and } A\,H = H\,D = \frac{S}{2}$$

By the law of the cubic parabola,

$$K\,E = S\left(\frac{S}{2}\right) = 4\,S$$

but

$$K\,E = E\,B + B\,K = S + d\left(\frac{T}{100}\right)^2$$

in which d = tangential distance for 100 ft. of given curve

$$\therefore S + d\left(\frac{T}{100}\right)^2 = 4\,S \text{ or } d\left(\frac{T}{100}\right)^2 = 3\,S$$

Offset s at any distance t from either end of spiral is found by formula

$$s = \left(\frac{t}{T}\right)^2 \left(\frac{S}{2}\right)$$

s being measured from the tangent or the inner curve as the case may be. This rule is applicable to curves of any radius, but for curves sharper than about 30° d should be taken for a less distance than 100 ft.

A table can easily be made for different values of S for a 1° curve, giving s for t = 10, 20, 30 feet, and used for any curve by multiplying S and s by the degree of the curve.

T remains the same while S divided by degree of curve is constant; s for values of t between those given in table is found by direct interpolation.

The following is such a table for S = 0.30 ft.

Spiral for 1° Curve.

S = 0.30 ft.	T = 101.4 ft.	S = 0.30 ft.	T = 101.4 ft.
t	s	t	s
10	.000+	70	.049
20	.001	80	.074
30	.004	90	.105
40	.009	100	.144
50	.018	101.4	.150
60	.031		

Yours respectfully, J. P. Newell,

Asst. Engr., O. R. & N. Co., Portland, Ore.

Walla Walla, Wash., April 5, 1897.

Sir: Knowing well the value of transition curves for street railway track as well as for steam railway track, I have read with interest the various methods of adapting such curves to street railway work, and must say that they all seem to me laborious both in theory and application. Two years ago I built an electric line in this city, with curves ranging from 80 ft. to 300 ft. radius, and as it was intended for a comparatively high speed line, transition curves were a necessity, on the suburban portion.

A curve based on the formulas of the Wellington Transition Curve was used, and for convenience in field calculations, there was substituted for D the degree of curve, 5,730 ÷ R. This left the necessary formula for calculation as follows: $\sin \tfrac{1}{2}\,I^\circ = \sqrt{\frac{3}{2}\,O} \div R$; and ½ curve length = I° × R ÷ 57.3 in which I° = centre angle in degrees subtended by the transition curve at one end; O = offset from tangent to P. C. of main curve; R = radius. The ½ length of curve is divided into 4, 8 or 16 parts, as the case may be, making each part as near 7.5 ft. (4 points to the 30-ft. rail) as possible, for convenience in bending rail. The curve is then laid off by means of ordinates from the tangent at the 4th, 8th or 16th points by the following table, which gives the ordinates in fractions and integral parts of the offset O:

0	.000	6	.211	12	1.688
1	.001	7	.335	13	2.145
2	.008	8	.500	14	2.680
3	.028	9	.712	15	3.296
4	.062	10	.977	16	4.000
5	.122	11	1.300		

This means that the copying of this small table and the two formulas given on the fly leaf of the field book of tables is the only outfit needed by the engineer. The track is spiked down up to a few rail lengths from the P. T. C. and a point on the rail to be bent is marked where it will come opposite the P. T. C., and then the rail is placed alongside the bender platform. An old flat car is good for this purpose, and where this car is not handy, four ties about 7.5 ft. apart are bedded in the ground at the curve, and the engineer places his tacks on the ties, not only for the various sections of the transition curve but also for the circular curve, and can then leave his "nigger" foreman with the "eagle eye" to bend the rail to the tacks as they are placed. The rail fits onto the curve with almost no springing into place, and with proper placing of the elevation according to the curvature, it is impossible to tell when the car enters and leaves a curve by the riding of the car. Curves put up in this manner when new, caused no lurching nor sliding of the car when on the transition part of the curve, while, on the circular part, the four wheel cars would slide as they do on all circular curves.

The method of choosing the offset and length of curve which depends on it, and all the theory and advantages of using this curve are contained in back numbers of Engineering News, in articles written by Mr. A. M. Wellington. The development of this curve and the formulas for its use were obtained by the writer from notes by Prof. C. L. Crandall, of Cornell University, who has since published those notes and they are now for sale, I understand. For the same radius of curve the same transition curve may be used, regardless of central angle, and for that reason a number of standard radii may be picked out beforehand, and the transition curves worked out ready for the use of the assistant peg-sticker who cannot figure beyond the bisection of the central angle. The writer did not have time to examine the amount of error at the limits, from the use of 5730 ÷ R instead of D, but it worked out beautifully in practice, and it seems that nothing better could be asked for in ease of riding of cars, especially the double-truck cars, and also the greater speed attainable from not having to slow up in passing those curves having the transition ends.

On this same line mentioned herein was a trestle over two railways with a skew angle of 44° on one road and 47° on the other road. The approach grades were 2½% on one side and 4.0% on the other, both down grades, and that left a vertical curve on a skewed trestle with stringers 27 ft. long. The only thing I had to be thankful for, was that a horizontal curve could be avoided. The working out of the details to keep the car level in passing over the curve and the bents, used up considerable "gray matter" before I got them straight, and as the president would allow no jack-stringers and long ties, the passengers can see nothing of the trestle as they pass over it, for the car hides it all. It was very necessary that there should be no tipping of the car nor side lurching, for that might make the passengers jump.

Very respectfully, L. F. Bellinger, M. S., C. E.

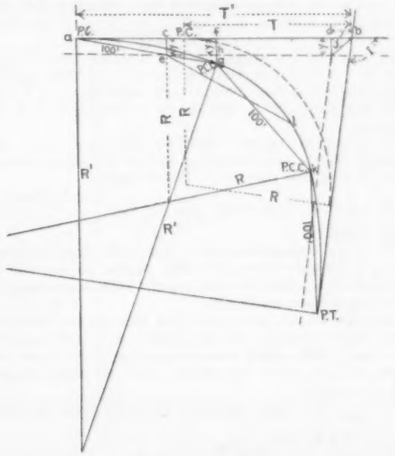
14½ No. Forsyth St., Atlanta, Ga., Feb. 11, 1897.

Sir: Below is given the solution of the easement curve problem, which I believe is worth being copied into all railroad transitmen's note books. Most of the formula either require two distinct solutions before the subtangent is found; or they increase the degree of curvature of the main curve by a few minutes, which is very objectionable. Also the solutions are long and complicated.

This formula allows the engineer to choose the degree of the main curve as well as that of the easement curve; and by so doing, simplify the field notes and help out the plotting of the same. The accompanying table reduces the amount of work to but very little more than that required for a simple curve solution. Yours truly,

Chicago, Ill., Feb. 1, 1897. E. P. Humphrey.

Demonstration.—The quantities x and y are small, and the difference between ac and ae is also small, but varies with the degree of the curve. An easement curve takes off a certain amount of curvature from the main curve



and replaces it by the easement; therefore, if main curve equals 4°, and 100 ft. of 1° easement is used, it would do away with 25 ft. of the main curve, and ae (see diagram) would be 75 ft., or $100\,\frac{D - D^1}{D}$, where D and D^1 are the numerical quantities.

With 3° curve and 1° easement, ae equals 66.66 ft.

Let lm = ordinary curve.
agk = curve with easement.
ag = easement curve.
I = angle of intersection.
J = ½ (180°—I).
u = P. C.
g = P. C. C.
D^1 = deflection of easement curve.
D = deflection of main curve.
ag = 100 ft.
gk = 100 ft.
el = 100 ft.

$$x = \frac{y}{\tan.\ J}.$$

$y = ae \sin. D^1$.
$fg = 100 \sin. D^1$.
$hg = eg \sin. D^1$.
$ae : ag :: D - D^1 : D$.
$ce : fg :: ae : ag$.

The point e is in the chord ag.

$y = 100\left(\frac{D - D^1}{D}\right) \sin. D^1$ (N. B. $\frac{D - D^1}{D}$ is considered as a fraction).

$ac = ae \cos. D^1$.
$af = 100 \cos. D^1$.

By construction sub-tangent $T^1 = T + x + ac$.

By substituting $T^1 = T + \frac{ae \sin. D^1}{\tan. J} + ae \cos. D^1$,

But $T = R \tan. \tfrac{1}{2} I$,

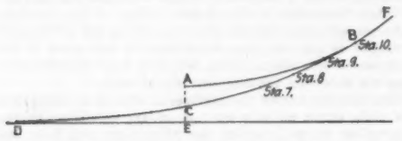
Therefore, $T^1 = R \tan. \tfrac{1}{2} I + \frac{ae \sin. D^1}{\tan. J} + ae \cos D^1$.

Deflection of Easement Curves.

	0° 30′	1° 00′	1° 30′	2° 00′	2° 30′
Degree of Main Curve.					
4 ae sin. D^1	9.815903	9.940825	.....	.....	.....
ae cos D^1	74.99	49.99	.....	.....	.....
5 ae sin. D^1	9.843932	0.020000	0.019979	.....	.....
ae cos D^1	79.98	59.99	39.99	.....	.....
6 ae sin. D^1	9.861658	0.065720	0.116889	.....	.....
ae cos D^1	83.33	66.65	49.98	.....	.....
7 ae sin. D^1	9.873823	0.095553	0.174555	0.174263	.....
ae cos D^1	85.67	71.39	57.08	42.77	.....
8 ae sin. D^1	9.882850	0.116916	0.213790	0.241789	.....
ae cos D^1	87.49	74.99	62.48	49.97	.....
9 ae sin. D^1	9.889744	0.132830	0.242945	0.207894	0.288400
ae cos D^1	88.89	76.79	66.68	55.57	44.46
10 ae sin. D^1	9.895085	0.144045	0.263017	0.320670	0.338850
ae cos D^1	90.00	79.99	69.98	59.96	49.96

Sir: The use of transition or easement curves on railroads to avoid the shock and swing due to the sudden change from a tangent or straight track to a circular curve is so well known that it needs no formal introduction to civil engineers of to-day. In running a line of railroad it is assumed that the engineer knows approximately the desired location of the circular curve AB with regard to the tangent DE, and wishes to put in an easement curve DCB.

R being the radius of the proposed circular curve ABF, offset the "point of curve" A from the tangent a distance EA equal to .0068 R, and run in the circular curve



ABF. Measure on the circular curve the distance A B = .2 R, and on the tangent the distance E D = A B. Set up the transit on D, measure the angle BDE and with the chord length $\frac{DB}{10}$ measured back from B and angle .81 BDE set sta. 9.

With the same chord length, and angle .64 BDE set sta. 8, and so on, always using the same chord length, and making the angle at each station one per cent. of BDE, multiplied by the square of the station number.

In case you are working in the direction from B to A and do not hit the correct position of A, thereby making AE more or less than .0068 R, then make DE = .10 R + 15 AE, and AB = .20 R. Set up on D and sight to B as before.

It is well not to use conditions which will make the lengths DCB of the transition part of the curve greater than .5 R or less than .3 R. Yours truly,

John F. Ward.

45 Broadway, New York, Feb. 16, 1897.

(1) Example.

To run in a transition curve DCB, ABF being required to be a 6-degree curve, R = 955. Setting up on A at a distance AE = .0068 R = 6.49 ft., at a right angle from E, run your circular curve ABF.

Measure AB on the curve, and ED on the tangent; each .20 R = 191 ft.; set the transit on D and measure the angle BDE, which should be about 3° 50'. Set the stake for Sta. 9 in the sketch, with the chord length $\frac{BA+ED}{10} = 38.2$, and with the angle from the tangent $= \frac{9^2 \times BDE}{100} = 3° 6'$.

For the other stations between D and B, use the same chord length (38.2), and on the angle from the tangent for

Station 8, $\frac{8^2 BDE}{100} = 2° 27'$,

" 7, $\frac{7^2 BDE}{100} = 1° 52'$,

" 6, $\frac{6^2 BDE}{100} = 1° 23'$,

" 5, $\frac{5^2 BDE}{100} = 0° 57'$,

" 4, $\frac{4^2 BDE}{100} = 0° 37'$,

" 3, $\frac{3^2 BDE}{100} = 0° 21'$,

" 2, $\frac{2^2 BDE}{100} = 0° 9'$,

" 1, $\frac{1^2 BDE}{100} = 0° 2'$.

(2) Example.

To run in a transition curve D C B, A B F being required to be of 1,000 ft. radius, and the offset A E from the end of the circular curve to the tangent being 18 ft. Measure A B on the curve .20 R = 200 ft., and E D on the tangent = .10 R + 15 A E = 100 + 270 = 370. Set the transit on D and measure the angle B D E, which should be about 3° 50'.

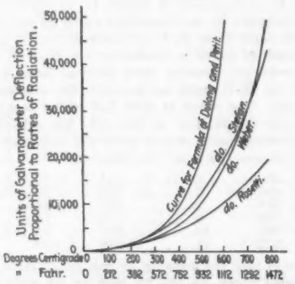
Set the stake for Sta. 9 in the sketch with the chord length $\frac{BA+ED}{10} = 57$ ft., and the angle from the tangent $= \frac{9^2 \times BDE}{100} = 3° 6'$. For the other stations toward D use the same chord length (57 ft.) and the angles as in (1.) example.

(3) Example.

To run in a transition curve D C B, the circular curve A B F being required to be of 100 ft. radius, and there being no offset at E. Measure A B on the curve .20 R = 20 ft., and E D on the tangent = .10 R = 10 ft. Set the transit on D, and measure the angle B D E, which should be about 3° 50'. Set the stakes for Sta. 9 in the sketch with the chord length $\frac{BA+ED}{10} = 3$ ft., and with the angle from the tangent $\frac{9^2 \times BDE}{100} = 3° 6'$. For the other stations between D and B, use the same chord length (3 ft.) and the angles from the tangent as in the first example.

COMPARISON OF FORMULAS FOR RADIATION OF HEAT.

A recent number of the "Polytechnic," published by the students of the Rensselaer Polytechnic Institute, contains an interesting paper by Prof. W. Le Conte Stevens, in which he makes a comparison of the various formulas for radiation of heat of Dulong and Petit, Weber, Stefan and Rosetti. He shows that Newton's law of cooling, which states that the rate of cooling is directly proportioned to the temperature difference between the radiating body and the medium surrounding it, is only approximately true when these temperature differences are small, and entirely fails when they are great. The assumption that the law is applicable when the initial temperature is 200° or 300° F., corresponding to the conditions of radiation from steam pipes and boilers, is unwarrantable. Dulong and Petit's law, published in 1817 and expressed by a complicated formula, has also been shown by subsequent investigators to be faulty. Prof. Rosetti,



Comparison of Formulas for Radiation of Heat.

of the University of Padua, Italy, published a new formula in 1879, as the result of his researches, and in the same year an Austrian physicist, Stefan, proposed another, which is remarkably simple in form and accurate over a wide range. A still more accurate formula, although more complicated, was proposed by Prof. H. F. Weber, of Zurich, Switzerland. Prof. Stevens reduces all these formulas to a common notation, and expresses them as follows:

Dulong and Petit $R = m(1.0077)^{T_0 - 273}\left(1.0077^{T-T_0}-1\right)$

Rosetti $R = a\,T^2\,(T-T_0) - b(T-T_0)$

Stefan $R = m\,T_0^4\left(\frac{T^4}{T_0^4}-1\right)$

Weber $R = C\,Fe^{a\,T_0}T_0\left(\frac{T}{T_0}e^{a(T-T_0)}-1\right)$

In these formulas R represents the quantity of heat radiated in a unit of time; m and C constants whose values depend upon the nature of the substance and the condition of its surface; a, a constant whose value in Dulong and Petit's formula is 1.0077; F the area of a radiating surface; e the base of the Naperian system of logarithms; T the absolute temperature, on the Centigrade scale, of the heated body, and T_0 the absolute temperature of the surrounding medium. In Rosetti's formula a and b are constants to be determined for the special instruments employed.

Prof. Stevens has made an experimental comparison of these formulas in their application to temperatures between 15° and 110° C. (59° and 230° F.), measuring temperatures directly with the thermometer and radiation with the thermopile. Under the conditions of the experiments it was possible to determine any difference to within a fraction of 1% between the requirement of theory and the result obtained by experiment. Within the selected limits of temperature this difference was never so great as 0.5% when Weber's formula was applied. For Stefan's formula the greatest deviation was about 6%.

Stefan's formula has also been tested by Dr. Schleiermacher, in Germany, who found that for low temperatures it gave results that are too great, and for high temperatures too small. This accords with the results obtained by Prof. Stevens.

The accompanying diagram shows the results of the comparison made by Prof. Stevens of the four formulas, using in them the constants determined from his experiments. The abscissas represent temperature differences from 0° to 800° C., (32° to 1,472° F.), and the ordinates are units of galvanometer deflection, which are proportional to the corresponding rates of radiation. Prof. Stevens concluded that of the various formulas offered an engineer for choice he will accept that which is easiest to apply, and at the same time accurate enough for the practical purpose in view. This combination is probably had to the best advantage in Stefan's formula, despite the superior accuracy of the one proposed by Weber.

AN EXPERIMENTAL ELECTRIC RAILWAY.

An experimental electric railway track, 6,700 ft. long, has been built by the General Electric Co., between its works at Schenectady, N. Y., and the Erie Canal. We are favored by the company with the following description:

The track is laid upon the heel path of the canal, and is of the same construction as the New York Central main line, with track rails weighing 85 lbs. per yd. Upon this track equipments are tried almost daily under different steam road conditions, with a view of developing feasible methods of traction for long-distance railways, including elevated and surface suburban roads.

The first section of the line is a tangent 2,415 ft. long, the second a series of short tangents and curves 1,635 ft. long, and the third another tangent of 2,730 ft.

Running along the track on the side away from the canal are the conductor rails. They are two 30-lb. rails, set on 8-in. ash blocks, which have been treated with "bergtheer" in vacuum pans and thoroughly impregnated. The two sets of conductor rails have been laid down for the purpose of experiment with alternating multiphase currents. For direct current experiments the two rails are connected in multiple. Both service and conductor rails are bonded with No. 0000 copper bonds.

The current is taken from the power house at the Schenectady works, over a feeder consisting of an insulated cable of 500,000 circular mils section, running by the track for a distance of about 5,300 ft. The line is divided into three working sections, each controlled by its own switch and semaphore. When this switch is closed, its section of conductor is made alive, and the movement of the switch handle sets the semaphore.

For a locomotive a special 8-wheeled car is used, which resembles a regular passenger coach, and is so constructed as to give an unobstructed access to the two motor trucks. Its weight, equipped, is about 30 tons. It is divided into three sections—a driving and testing department in front; a passenger division in the center, and a rear compartment in which are carried the air pump, tools, etc.

The equipment of the forward compartment consists of a skeleton wooden switchboard carrying the ammeters, voltmeters, wattmeters, etc., to enable the engineer to gage exactly and record the performance of the specific motor equipment which may be under test. The switchboard is also fitted with the necessary quick break switches, magnetic blow-out, fuse boxes, automatic circuit breakers, etc. The controller is set in front of the right forward front windows, through which the driving engineer has an unobstructed view of the track in front of him. To his right is the valve handle of the air brake, and in front of him is an operating ammeter gaging the current output. The resistances are suspended from beneath the central compartment.

In a recent test the equipment of the car consisted of four G. E. 2,000 motors—each motor being rated at about 125 HP.—one motor to each axle, motion being communicated to the wheels through a steel gear and pinion. The forward truck was equipped with a speed recorder. The controller used was a K-16-series-parallel controller.

From beneath the bolster of each truck set between the wheels on the conductor rails' side projects a heavy oaken beam, to which is suspended the contact shoe by means of which the current is carried from rails to motors. The shoe is a flat piece of cast iron with the ends slightly curved. It is fastened by two loose links to an iron casting bolted to the oak beam. This method of suspension keeps the shoe continuously in contact with the surface of the conductor rail as it allows it to conform immediately to any inequalities which may occur in the latter.

The air for the brakes and whistle, one of which is set at each end of the car, is furnished by a vertical direct-connected air pump, operated by a motor controlled automatically by balancing the pressure in the air tanks against the power of a spiral spring. The spring is coiled in a cylinder furnished with a piston, the upper end of which is a switch in a magnetic blow-out device. As soon

as the pressure in the main tank falls below that desired, the spring forces up the piston until its upper end is in contact at the switch, when the motor circuit is closed and the air pump motor starts. As soon the the pressure rises to normal the piston is forced back, the circuit is broken and the motor stops, any arc at the point of rupture of contact being immediately extinguished in the magnetic field of the blow-out device.

The first test made with the motor equipment, the total drawbar pull of which is about 15,000 lbs., consisted in the hauling of four flat cars loaded with pig iron. This load, about 121 tons, was easily handled by the locomotive, with satisfactory records as to speed and power required.

The locomotive was then coupled to four New York Central standard passenger coaches, making with the motor car a train of 130 tons. Several runs were made with this train with equally encouraging results.

CIVIL SERVICE EXAMINATIONS FOR ENGINEERING POSITIONS IN BROOKLYN.

Examinations will soon be held by the Civil Service Commission of the City of Brooklyn for the following positions: Assistant Engineer of Street Construction, Leveler, Draftsman and Assistant Draftsman. Application blanks may be obtained by addressing the secretary of the Commission, Mr. Edward B. Lent, Room 1, City Hall, Brooklyn, N. Y. Applications should be filed before April 19. We are indebted to Mr. Lent for copies of circulars containing the duties and qualifications of the respective positions, and also showing the questions asked at the last examination. As the questions of civil service reform and civil service examinations are still under discussion in many localities, many of our readers may be interested in knowing what kind of examination is given to candidates for such positions as those named above. We therefore quote from the circulars the following extracts concerning the questions asked at previous examinations:

Leveler. Maximum salary, $1,200 per annum.

Applicants will be examined as to their knowledge of the requirements of the position. The experience and testimonials of applicants, in the form of vouchers, which become a part of their application papers, will also be rated.

The maximum rating in each branch of the examination will be as follows: Testimonials, 20; experience as stated by candidate, 20; technical knowledge, 60. The required minimum in each branch is generally 70% and an average minimum of 70% is required.

The following questions were asked at the last examination:

What are the adjustments of the Y level?
Show the method of recording notes of a level survey, along the route of a proposed road.
What are benches? What is a datum line?
How would you record notes of a cross section survey for a road?
How would you measure and estimate a borrow pit?
What is the prismoidal formula?
In mapping a profile, what distinction is made between horizontal and vertical scales?
What is the general method of making a topographical survey?
In the survey of a road or railway, what work precedes the leveling?
Which of the adjustments of the level requires to be renewed most frequently?
Tell about the transit; how it is set up for use, and its adjustments tested.
Applicants will be required to adjust the level.

Draftsman, Grade A. Maximum salary, $1,500 per annum.

The scope of the examination is indicated by the following questions, which were asked at the last examination:

Exhibit two ways of mapping contour of ground.
Sketch the outline of this survey: (a) N. 61° W. 400 ft.; (b) N. 42° W. 410 ft.; (c) N. 12° E. 161 ft.; (d) N. 47° E. 325 ft.; (e) S. 22° E. 946 ft.
Tell what you can of the magnetic meridian.
What are the topographical signs for marsh and for woodland?
What field notes do you require to enable you to draw a profile of a proposed road?
Draw a ground plan and two elevations of a retaining wall or dam.
Applicants must exhibit specimens of their own work.

Assistant draftsman. Maximum salary, $1,000 per annum.

The following questions were asked at the last examination:

Show how to bisect a given angle.
Draw a tangent to a circumference at a given point in the circumference.
Draw a sketch of a line of shore.
Sketch the traverse line S. 16 W., 250 ft., S. 70 W., 100 ft.; West 100 ft.
What is the magnetic meridian?
How are hills represented in maps?
Show how a marsh is represented.
How can a table of sines be used in laying off angles?
How is the area of a trapezoid found?
Applicants are required to exhibit specimens of their own work.

Assistant Engineer of Street Construction. Salary, $2,600 per annum.

Applicants will be examined as to their knowledge of the requirements of the position. The experience and testimonials of applicants, in the form of vouchers, which become a part of their application papers, will also be rated.

The maximum rating in each branch of the examination will be as follows: Testimonials, 20; experience as stated by candidate, 20; technical knowledge, written, 40, and oral, 20. The required minimum in each is generally 70%, and an average minimum of 70% is required.

The duties and qualifications of an assistant engineer of street construction are thus outlined by the commissioner of city works:

His duties will consist of the preparation of plans and specifications and the general charge of the construction of asphalt, granite and brick pavements and of macadamized roads. The necessary qualifications are that applicants shall be civil engineers of thorough technical training and experience in municipal engineering, having been for not less than five years in responsible charge of the construction and maintenance of asphalt and granite pavements. The examination should test his technical knowledge of these subjects and his statement of experience should be detailed and specific, showing the amount and value of work of which he has charge, as well as the time covered by such work.

THE OLIN GAS AND GASOLINE ENGINE.

In the accompanying cuts we illustrate somewhat fully the Olin gas and gasoline engine, manufactured by the Olin Gas Engine Co., of Buffalo.

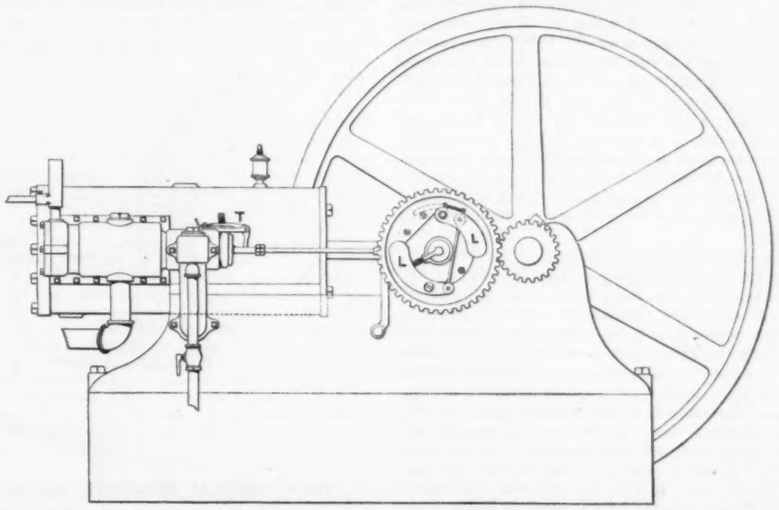


FIG. 1. -SIDE ELEVATION OF OLIN GAS ENGINE, WITH FLY-WHEEL REMOVED TO SHOW THE GOVERNOR AND VALVE GEAR.

This engine is of the single-acting four-cycle type, the piston receiving an impulse each alternate outward stroke. Fig. 1 is a side elevation showing the general arrangement and location of the air and gas pipes, the governor, admission and exhaust valves and other essential parts, and Fig. 2 is a horizontal section through the cylinder and valve chamber. Fig. 3 is the valve chamber drawn to larger scale and Figs. 4 and 5 show the air and gas inlet valve and the governor, respectively.

Referring to Fig. 2, it will be seen that the cylinder is open at its forward end, as is usual with single acting engines. The piston is of the trunk type and is connected with the crank by a forged steel connecting rod. The crank is cut from a solid steel forging and the crank shaft carries two fly wheels and a pinion gear which operates the governor. All bearings are of bronze or Babbitt metal. The cylinder is water jacketed.

The construction of the valves is shown by the vertical longitudinal section, Fig. 3, and the vertical transverse sections, Fig. 4. The air is received through the curved pipe A, having an annular inlet to the valve chamber controlled by the poppet valve B. The same valve B controls the gas admission from the reservoir through the opening C, and the gas and air thus admitted enters the hollow exhaust valve stem D through the orifices at E. At the inner end of the hollow exhaust valve stem is a loose ring F, upon which the admission valve G rests. In entering the cylinder the gas and air thus pass through the check valve, undergoing a partial admixture in the process, enter the valve stem D through a number of small orifices and are further mixed and pass along the hollow stem, to be admitted finally into the cylinder through the admission valve G.

The method of exhausting the burned gases can be seen from Figs. 2 and 3. As the explosion forces the piston forward, the port H is opened and the greater part of the burned gas exhausts through the passage J, the remainder being driven by the return stroke of the piston through the passage K opened by the movement of the valve stem D toward the left. The stem D is operated by means of a rod actuated by the governor, this governor being of the class which operates by

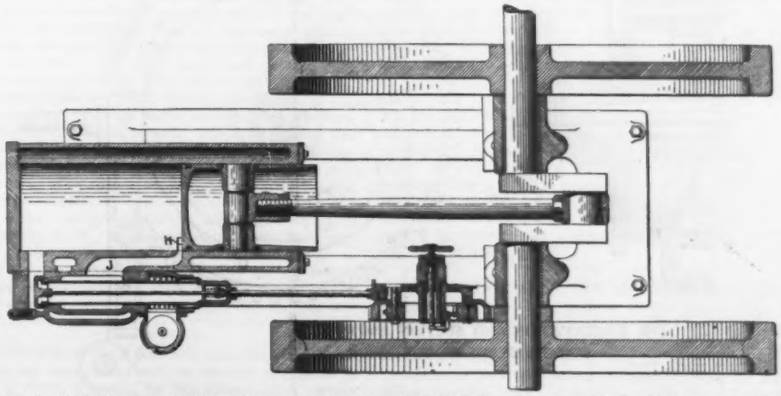


FIG. 2.—HORIZONTAL LONGITUDINAL SECTION THROUGH CYLINDER AND VALVE CHAMBER OF OLIN GAS ENGINE.

holding the exhaust valve open and the admission valve closed when the speed gets above the normal.

Fig. 2 shows the location of the governor on the engine, and Fig. 5 gives enlarged details of the governor itself. Briefly described, the governor consists of two weights L, a spring M, a finger N, controlled by the weights and spring, a rider disk O on the back of the gear, and a rocker arm having a roller P and a dog R. The tension of the governor spring may be varied as desired while the engine is running by means of the small hand wheel Z attached to a stem passing through the pin upon which the gear turns. This stem presses upon a bell lever, to one end of which the governor spring M is secured. The pin upon which the gear revolves is turned eccentric, so that the mesh of the gears can be set to a nicety to ensure quiet running, and is also made hollow and so arranged that it can be oiled while the engine is in motion.

In operation, the engine piston on the first outstroke draws in a mixture of gas and air, as already explained. On the return stroke the charge is compressed, and just as the crank is passing the back center it is fired, forcing the piston forward. As the piston nears the limit of this second out-stroke it uncovers the port leading to the exhaust pipe, thus relieving the cylinder of the terminal pressure and the greater part of the burned gases. Now, as the piston begins the second in-stroke, the rocker arm roller P runs upon the exhaust cam S, which forces the exhaust valve from its seat and holds it open during the return stroke. This cycle of operations is repeated as long as the speed remains at or below the normal, but as soon as the speed goes above the normal the governor weights L throw out so as to depress the finger N sufficiently to enable it to slide under the dog R and cause the latter to ride on the rider disk O. This holds the exhaust valve open during the whole cycle, and instead of the engine taking a new charge the piston simply reciprocates freely, drawing in and forcing out a part of the exhaust gases. The admission valve G is held closed by the lever and spring T, Fig. 1, which holds fast the valve stem.

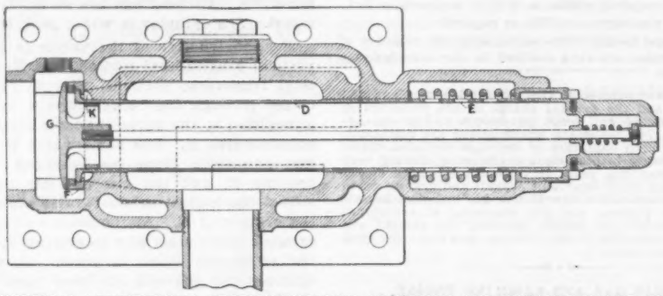


FIG. 3.—VERTICAL LONGITUDINAL SECTION THROUGH ADMISSION AND EXHAUST VALVE CHAMBER.

From the preceding description and illustrations the general construction and details of operation of the gas engine under consideration will be pretty clearly understood. Ignition is accomplished either by an incandescent tube or by an electric spark, as may be desired, but the builders recommend the former method as preferable, owing to its simplicity and ease of maintenance and repair. The starting of the engine is made easy by the use of a cam shown by dotted lines at Y, Fig. 5. This cam is raised by hand and held in position by a small catch before starting the engine. It comes into action during the first half of the compression stroke and forces the exhaust valve from the seat for this period. By the use of this device, all the force of the starting impulse is utilized, as none of it is allowed to escape until near the termination of the working stroke. A special starting device is used with very large engines. The gasoline engine is made up by the addition of a simple pump operated by an arm attached to the hub of the rocker arm. This device is of the simplest kind and easily accessible.

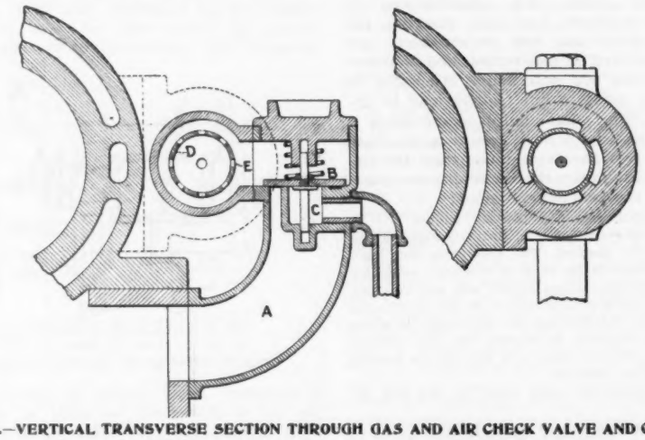


FIG. 4.—VERTICAL TRANSVERSE SECTION THROUGH GAS AND AIR CHECK VALVE AND CHAMBER.

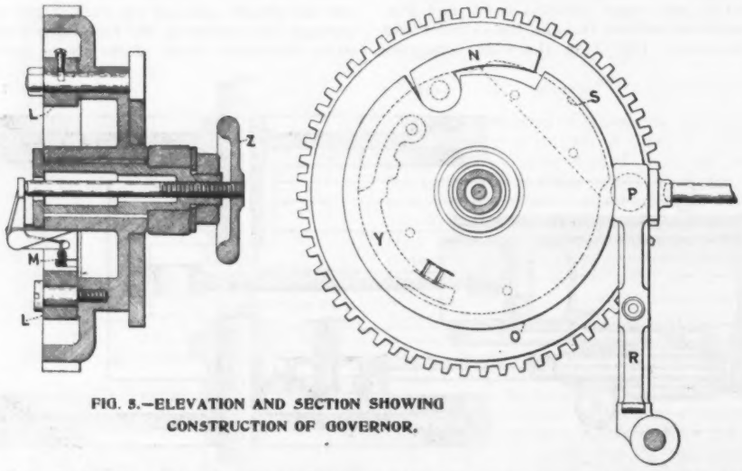


FIG. 5.—ELEVATION AND SECTION SHOWING CONSTRUCTION OF GOVERNOR.

In regard to the efficiency and economy of the Olin gas engine, we have only the general statement of the manufacturers, which in a letter to this journal is given as follows:

The Olin engines are in successful operation and use for running dynamos to furnish incandescent lights, also in publishing houses for running linotype machines where absolute steadiness of motion is required. Reports have been received from purchasers of Olin gas engines, who have been running them to their full capacity, showing a consumption of natural gas as low as 11 cu. ft. per HP. hour. The company guarantees a maximum fuel consumption on engines of 10 HP. and above, of 15 cu. ft. of good gas or one pint of gasoline per HP. hour. Its claims for superiority over other makes are simplicity of construction, easy accessibility of working parts, freedom from fine adjustments, economy of fuel consumption, easy starting, strength and durability and safety and reliability.

It will be remarked that the economy in gas consumption claimed is something quite surprising. Doubtless indicated and not brake horse power is meant, and the tests must have been made under extremely favorable conditions.

NATURAL DISTORTION OF ROCK IN PLACE ON THE CHICAGO DRAINAGE CANAL.

The "Journal of the Western Society of Engineers," for February, 1897, contains a paper on the above subject presented by Mr. Chas. L. Harrison. The paper is illustrated by photographic views of the phenomena discussed. A brief abstract follows:

The outcropping rock in the Desplaines valley is Niagara limestone, a sedimentary formation with a nearly horizontal stratification. This rock is checked with parallel vertical seams or fissures, running northwest and southeast, with similar checks at nearly right angles to these. The effect of these fissures is to divide the mass into nearly rectangular blocks varying in length from a few feet to about 100 ft. in extreme cases. The vertical seams are usually close, but many of them vary from one-half inch to one foot in width and these are filled with clay.

Forces of great magnitude were certainly required to produce these changes in the position of the rock strata, faults of a few inches to 30 ft. being observed. But while many of the changes were produced in a past of unknown length, effects observed during the excavation of the canal lead to the belief that these same forces are still at work producing similar changes under favoring conditions. The canal channel was excavated in the rock in three lifts of 10 to 12 ft. each. During this work a slight rising of the surface of the ground would occur, sometimes in the second lift a short time after the first lift was excavated; after the second was taken out this rising would develop at the top of the third, and when this was removed it would show in the bottom of the canal. These surface distortions varied in height from a few inches to 15 ins. Some rose like a large blister, 100 ft. in diameter and attaining a centre height of 6 ins. in two weeks.

In excavating the canal the sides were first cut with a channeling machine before any rock was blasted. The cut made by these machines was 2¼ ins. wide at top and 1¾ ins. wide at the bottom of a cut 12 ft. deep. It was frequently observed that the sides of this cut would close tow-

ards each other in a few days, and on one section a cut 50 ft. long and 12 ft. deep closed more than one inch between November, 1893, and June, 1894. The workmen explained this by saying that "the rock is creeping," and such distortion or movement has been observed in quarries and mines practically all over the world. Risings of the same character have been noted in all of the stone quarries in the Desplaines valley, and they have been variously ascribed to the effects of exposure to air, to the heat of the sun, to water and to chemical changes in the rock itself. They develop under many varying conditions, and changes take place when the rock is under water and protected from temperature changes, when exposed to the direct rays of the sun, and when covered with ice and snow. They also exist in rock covered with 15 to 20 ft. of glacial drift.

Mr. Harrison believes that the most plausible theory is to be found in internal stress in the rock itself; the effect being similar to that resulting from the hardening of the exterior crust or shell of a great sphere, while lower strata are still cooling and continually shrinking away from the rigid outer shell. Under such conditions it may be assumed that an initial stress has been imposed upon some of the nearly horizontal strata in this valley, which has no appreciable effect upon the surface until the equilibrium is destroyed by a change in conditions brought about in the excavation of the canal.

Several failures occurred in the retaining walls built upon this horizontal rock strata. One case of unusual interest was noted by the writer. This was a wall about 14 ft. high, 105 ft. long on the bottom and with both ends abutting against the natural rock. Before this wall was built the rock in the channel had been removed and all blasting operations were distant at least 100 ft. The filling behind the wall was not yet in place, and the wall stood alone upon a natural rock foundation. But on Nov. 1 an examination of the up-stream 25-ft. of this wall showed that a number of the stones in the wall were crushed, and more of the broken stone were found in the bottom of the wall than elsewhere. There was a vertical longitudinal crack, about 10 ft. long and ½-in. wide, in the top of the wall, and the face of the wall had moved towards the channel and the back of the wall from the channel. The break was evidently due to end pressure, and this was doubtless materially assisted, if not produced, by the slight earthquake which occurred on Oct. 31, the night before the failure was noted.

A PROPOSED TAX ON TELEGRAPH POLES has been in litigation for some years between the City of St. Louis and the Western Union Telegraph Co. The city laid a tax of $15 per year on 1,509 poles, or $22,635 per annum. The company was sued for this amount and the U. S. Supreme Court has now rendered a decision against the city, the tax being considered neither just nor equitable. With this suit settled the telegraph company may now accept the remainder of the city ordinances relating to wire-using corporations and place its wires underground.

THE TUBULAR DISPATCH CO., of New York, has entered into a contract with the government to construct and operate a pneumatic tube system for collecting and distributing mail matter in New York city. The system would be divided into eight sections of double lines of tubes, each ranging in length from 15,000 to 50,000 ft. The tubes would be cast-iron, 8 ins. inside diameter, with brass bends, and each carrier would be about 21 ins. long and 6⅞ in. diameter. A similar system is now in use in Philadelphia over a total length of about 6,000 ft. This tube is 6¼ ins. diameter and the carrier is only 18 ins. long; but each carrier has a capacity of 200 letters and they can be despatched at 6-second intervals, making the tube capacity 240,000 letters per hour, including both directions. The actual speed in practice is about 52 ft. per second, in the Philadelphia service, and in the four years it has been in use it is estimated that more than 35,000,000 letters have been despatched through these tubes, with but one serious interruption due to an obstruction in the tubes. This obstruction, the means adopted for removing it, and further description of the Philadelphia service were noted in Engineering News of March 4, 1897.

EXHAUSTING INCANDESCENT ELECTRIC LAMPS by the "chemical" method at the Edison lamp works is described in the "Electrical Engineer." Heretofore the exhaustion has been accomplished by the Geisler or Sprengel vacuum pumps, but recently a mechanical pump has been found by which a very high vacuum could be obtained, exhausting one lamp at a time, and nearly the entire product of the factory is now exhausted by these pumps. The pump is quite a small one, set on a bench, and provided with two cylinders, each employe using one cylinder only. After using the pump the vacuum is perfected by what is known as the chemical method, which is thus described:

The natural residual gases in an incandescent lamp may be called conducting gases, as they allow currents to pass through them from one leg of the filament to the other. Their removal requires a long time on the mercury pumps generally used. By the new method, usually called the chemical exhaustion, when a pump has taken out all but the residual gases, a gas capable of combining with these residual gases is introduced into the bulb. Previous to this introduction, the bulb, while the carbon is at a high degree of incandescence, is filled with a sort of blue glow; shortly after the introduction of the gases, and while the carbon is still at a high degree of incandescence, the blue glow suddenly disappears, indicating that a combination has taken place between the natural residual gases and the introduced gases. When this combination takes place the lamp is ready to be sealed off, and the vacuous space is found to be in a thoroughly insulating condition.

OIL LIGHTING BY A CONSTANT SUPPLY is being exploited in London by the Imperial Oil Lighting Co., of 43 Cannon St., London, says "The Engineer." The chief feature of the system is a main reservoir, preferably placed outside the building and high enough to give the requisite head. A system of piping connects the lamps with this tank and an automatic governor on each floor regulates the flow of oil. The lamps are of special design and do not require a large container, the wick alone being kept fully immersed.

THE STEEL SEA-GOING BATTLESHIP "IOWA" made a most successful trial trip, on April 7, over the Cape Ann deep water course of 66 nautical miles. The official speed statement has not yet been made public, but the indications are that she has surpassed her contract speed of 16 knots by from half a knot to a knot. The "Iowa" was built by Wm. Cramp & Sons, at Philadelphia, under a contract made on Feb. 11, 1893, for $3,010,000 for hull and machinery. Her general contract dimensions are: Length on load water-line, 360 ft.; extreme beam, 72 ft. 2½ ins.; mean draft, 24 ft.; displacement, 11,410 tons. Her engines were to develop 11,000 I. HP. and her normal coal capacity is 625 tons, with 1,780 tons bunker capacity. Her main battery includes four 12-in. and eight 8-in. breech loading rifles and six 4-in. rapid-fire guns; her secondary battery contains twenty 6-pdr. and four 1-pdr. rapid-fire guns and four Gatling guns. There are five torpedo tubes and her armor is 14 ins. thick on the sides, 15 and 5 ins. on the turrets, and 15, 8 and 6 ins. on the barbettes. There is a 2¾-in. flat protective deck and one military mast. We are informed that the "Iowa" is fitted by the Geo. F. Blake Mfg. Co. with vertical twin air-pumps for the main condensers and with feed, fire, water service, wrecking and bilge pumps.

TORPEDO BOAT No. 3 made a builders' trial trip, in Chesapeake Bay, on April 7. With a maximum of 250 lbs. of steam, and an average of 205 lbs., her screws made 390 revolutions per minute and an average of 307. The contract speed is 24½ knots, but she made 25 knots, and her builders think she can make 26 knots. No. 3 is a steel boat, 160 ft. long, 16 ft. beam and 5 ft. depth of hold. She is one of three of the class being built by the Columbian Iron Works & Dry Dock Co., of Baltimore, Md.

THE ARMOR PROPOSALS, called for by the U. S. Navy Department for the equipment of the three battleships, "Illinois," "Wisconsin" and "Alabama" only brought out one bid on April 8, the day set for the receipt of bids. This was from the Illinois Steel Co., proposing to supply 8,000 tons of armor at $260 per ton; provided, that a 20-year contract for all the armor wanted was given to this company. Under the directions of Congress the Secretary of the Navy had called for bids at a price not exceeding $300 per ton. The Bethlehem and the Carnegie companies presented written statements of the reasons compelling these companies to refrain from bidding at all under the conditions named. The Illinois Steel Co. also proposed that all armor over 8,000 tons should be supplied for $240 per ton, and as an alternative proposed that the government erect an armor plant at the South Chicago Works, to be supplied by open hearth basic steel by the company named, the ground for the plant to be rented to the government at $1. As the bid received was irregular, Secretary of the Navy Long has referred the matter to Congress, and recommends that authority be granted to readvertise for proposals at a price not exceeding $400 per ton, in conformity with the price suggested by the late Secretary of the Navy.

STERN-WHEEL STEAMERS with two wheels and compound engines have been built by Easton, Anderson & Goolden, of Erith, England, for the African river service of the Royal Niger Co. The hull is of steel, 317 ft. long, 27 ft. beam, 6 ft. deep, with a draft of 26 ins. The square stern is indented or cut away at each corner to make room for a wheel 11 ft. diameter, with eight floats, 5½ × 1½ ft. The center part of the hull is extended between the wheels and forms the support of the shafts, the sides being curved inward to give a free flow of water to the wheels. The wheels normally work together, but the shafts may be disconnected by a clutch. Each engine has two inclined cylinders, 10 × 36 and 22 × 36 ins., the low pressure cylinder being below and the high pressure cylinder above the center line of the shaft. The centers of the cylinders are four ins. apart laterally to allow for the passage of the connecting rods. The Stevenson link valve gear is used. Steam is supplied by a single-ended cylindrical boiler 9¾ ft. diameter and 9½ ft. long, with two Morison's 36-in. flues and 3½-in. tubes. It has a grate area of 36 sq. ft. and a heating surface of 1,000 sq. ft. On the trial trip, with a boiler pressure of 126 lbs., the engines developed 188 I. HP., at 43 revolutions per minute, and gave the vessel a speed of 7.38 knots per hour.

A PERMANENT EXHIBITION OF MACHINERY is about to be established in Callao, Peru, by the Peruvian government, for the object of promoting the introduction of various branches of industry into the country. Foreign exhibits will be admitted duty free. The exhibition will open on July 28.

AN EXHIBITION OF MOTORS AND MACHINE TOOLS is to be held at Munich, Germany, in 1898, by the General Industrial Association of Munich. The object is to exhibit such machines and auxiliaries as tend to improve industry and the arts, as well as to instruct and encourage manufacturers and make them acquainted with the scientific and technical inventions and improvements of our day. The exhibition will include motors, machine-tools, hand-tools, implements, apparatus and machinery in motion, as well as the raw materials to be worked up, and the manufacturing processes in operation. Motors of over 10 HP., and tools or machines requiring greater driving power, such as steam hammers, lathes, rolling-machines and the like will be excluded. Popular lectures on special scientific and technical branches will be delivered, and technical literature on these subjects will be exhibited. The classification will be as follows: Group 1: Motors; gas, petroleum, benzine, steam and hot-air engines, machinery driven by water and wind power, and electric motors up to 10 HP. Group 2: Machine-tools, hand-tools and implements. Group 3: Auxiliary machines, as pumps, ventilators, presses, cranes, clocks, parts of machines, electrical arrangements, safety appliances, apparatus, auxiliary materials. Group 4: Manufacturing processes in operation, and machinery in motion. Group 5: Special technical literature. Information may be obtained from M. Nagler, President of the Board of Directors of the Second Exhibition of Motors and Machine Tools, 1½ Farbergraben, Munich, Bavaria, and at the German Consulates.

THE ATTACK ON THE CAST-IRON PIPE TRUST has been renewed at Chattanooga. A few weeks ago it was noted in these columns that a preliminary injunction against the trust had been dissolved. Press dispatches now state that a Federal grand jury has returned an indictment against the Associated Water & Gas Pipe Cos., on the charge of unlawful combination, in violation of the Sherman anti-trust act.

AN EVEN $2,000,000 FOR TWO STREET RAILWAY franchises in New York city has been offered to the city authorities by Mr. H. J. Baker, of 95 William St. The roads are the Sixth and Eighth Ave. lines, which have been in operation for many years, but which the city has the right to buy at their cost price plus 10% additional.

BOSTON'S NEW SELF-PROPELLED FIRE ENGINE, which was recently briefly described in these columns, has been tested for its water delivery. Six tests were made under the following conditions: Through one 200-ft. line of 3-in. hose with a 1½-in. pipe; through two 200-ft. lines of 3-in. hose with a 1¼-in. pipe; these two lines siamesed into a 1⅝-in. pipe; then through a 1¾-in. pipe; then through a 2-in. pipe; through one 50-ft. line of 3½-in. hose with a 2-in. pipe. The steam pressure averaged 125 pounds. All of these tests were very satisfactory. The firemen estimated that the siamesed streams would be efficacious from the street to a height of eight stories of a building. A register used to determine the amount of water pumped showed a maximum of 1,550 gallons per minute. This was accomplished at a speed of 443 revolutions, and is 200 gallons in excess of the contract requirements of the engine. The maximum capacity of the largest land engines at present used in the department is 961 gallons a minute.

THE EXTENSION OF THE RIVERSIDE DRIVEWAY, in New York city, is authorized by the Austin-Ford bill just passed by both houses of the New York Legislature. The driveway would be extended by a viaduct across Manhattanville Valley and connect with the existing Boulevard Lafayette at 159th St., above Washington Park, on Washington Heights. The estimated cost is $2,000,000, one-half to be paid by city bonds and one-half by the owners of the property benefited. This bill is a substitute for one calling for more elaborate and extensive improvements involving an expenditure of about $10,000,000.

THE GILSONITE, or asphalt, deposits on the Uncompahgre Reservation, in Utah, still interfere with the open-

ing of this land to public entry. The Utah Senators argue that it is for the public interest that these mineral deposits should be mined, and deem public entry as the most simple way of bringing this about. The Interior Department has refused to throw the lands open, contending that no agreement has yet been made with the Indians on the reservations. The charge is made outside that Eastern capitalists were most interested in making the beds of gilsonite accessible; and Congress must now decide between these parties.

A RAILWAY WITHOUT CARS is being operated in the Cascade Mountains in Oregon, in hauling logs for the Bridal Veil Lumber Company. The railway is about five miles long, has a gage of 3 ft. and is built like an ordinary road, except that stout planks are fastened to the ties to form a roadway for the logs to be hauled upon, the rails acting as guards to keep the logs on the track. The logs themselves are connected in a long line by staples and chains, and the planks are well greased, except on sharp inclines. An 18-ton Baldwin locomotive hauls the logs out of a so-called chute-pond, near the head of the line, the logs having been previously assembled in a long line in the water and fastened together. Another flume on the line is used to slide the logs into another pond, the logs having been first disconnected, and at the end of this second pond the logs are again assembled and hauled out as before and on to the lumber mills.

THE RUSSIAN RAILWAY MILEAGE, at the beginning of 1897, amounted to 26,946 miles. In 1896, 1,425 miles of new railways were put into operation and 1,390 miles were completed, but not yet operated, making 3,615 miles of new construction for the year. There are also 5,525 miles of railway in course of construction by the state and private companies, and many new lines have been authorized.

AN APPROACH TO PERPETUAL MOTION has been made in a toy machine constructed by Mr. H. H. Freeman, of Pierre, S. D., according to a letter written by him to the Minneapolis "Times" of March 15. Acting on the idea that the forces which bring to rest a wheel once set in motion are the friction of the bearing, which is due to gravity, and the friction of the air surrounding the wheel, he supported the axle of a wheel in bearings and suspended over them a magnet of sufficient power to nearly overcome the force of gravity which held the axle down in the bearings. He then formed a vacuum for the wheel to run in by inverting over it, after setting it spinning, a tumbler whose inner part was subjected to a strong current of steam, sealing the edges with sealing wax, and allowing the steam to condense. Mr. Freeman writes that at the time this was done, nearly two years ago, the wheel was making 257 revolutions per minute, and at this date there is no perceptible diminution of its speed.

We give the story as we find it, and our readers can believe it or not, as they please.

BOOK REVIEWS.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE.—Vol. L. Edited by Bennett H Brough, Secretary. London, E. & F. N. Spon, Ltd. New York, Spon & Chamberlain. Cloth; 8vo.; pp. 507.

The first half of this volume is devoted to the proceedings of the meeting of the Iron and Steel Institute, held in Spain in Sept., 1896. The two principal papers read at this meeting were one on "The Iron and Steel Industries of Spain," by Don Pablo de Alzola, Director of the Altos Hornos Co., of Bilbao, and one on "The Present Position of the Iron Ore Industries of Biscay and Santander," by Mr. William Gill, M. Inst. C. E., of Bilbao. The latter paper is especially rich in statistical matter, and is handsomely illustrated with colored maps, photographs, etc. The former gives some very clear statements concerning the industrial position of the mining industries of Spain in relation to their benefit to the country, from which we abridge the following extracts:

It is evident that of the iron ore mined in Spain, not more than one-tenth is converted into pig iron, the remainder being exported. As regards copper, the situation is even more unfavorable, for, although Spain possesses the magnificent deposits of Rio Tinto, the native manufacture is confined to the rudimentary calcination necessary for obtaining the burnt ore, and almost all the raw material is handed over to other more fortunate countries, where it is converted into metal for use for machine construction, electrical engineering and the decorative arts.

It is difficult to realise the pernicious influence that will be produced in the future of Biscay by the exhaustion of its ores. If, as in Spain, every possible facility is given to foreigners to acquire property, as is not the case in all countries, foreign capital should, at any rate, be directed to promoting the permanent good of the country rather than to conferring upon it a fugitive and ephemeral prosperity. It would be idle to deny that fortunes have been made out of mining in Biscay, and, in view of the fact that the commercial management of manufacturing concerns is much more difficult, and that the result profits to capitalists are very moderate, it is natural that mining should be preferred to metallurgy. This, however, as has already been pointed out, is due to the defective economic organization in Spain. In short, in Spain matters have been arranged in a way best adapted to stimulate the extraction of raw material, and consequently greater facilities have been given for exporting ore than for manufacturing iron. If matters had been arranged differently by stimulating in Biscay the manufacture of steel, and by imposing some restrictions on the exports of ores, the future prosperity of the country would be assured.

It has been asserted that in the southern districts of Europe there is no aptitude in the race for manufacturing affairs. This is, however, a common error. The inaptitude attributed 25 years ago to Spanish engineers in the matter of constructing and working railways has ceased, facts having shown the fallacy of the assertion. The similar prejudice, still existing in official circles, which deprives the national trade of the building of war ships for protecting the mercantile marine is also disappearing in the face of the magnificent progress made in the Italian ship yards, and of the war-ships built in Spain.

The latter half of the book contains the usual abstracts from various sources of note on the progress of home and foreign iron and steel industries, including statistics of production in the leading iron producing countries.

GAS, GASOLINE AND OIL VAPOR ENGINES.—A New Book descriptive of their Theory and Power, Illustrating their Design, Construction and Operation for Stationary, Marine and Vehicle Motive Power. A work designed for the General Information of every one interested in the new and popular Prime-Mover, and its Adaptation to the increasing Demand for a cheap, safe and easily-managed Motive Power. By Gardner D. Hiscox, M. E. New York: Norman W. Henley & Co. Cloth; 8vo.; pp. 279; 206 illustrations; $2.50.

The reason for the appearance of this book is given by the author in his preface as follows:

The entire absence of any literature on explosive motors as made in the United States other than such as has been published from time to time in journals and magazines, and in view of the constant inquiry of persons interested in the use of motive power as to the various styles and designs of gas, gasoline and oil engines and the principles of their working, have induced the author of this work to put into a practical shape for the ordinary reader the principles and practice of the operation of this class of motors as made principally in the United States.

What the author says as to the absence of good literature on American types of engines is true, but there are two excellent and up-to-date English treatises on internal combustion motors, and probably not less than nine-tenths of American gas engine builders are merely copying English and continental practice. His prefatory reasons, therefore, are hardly sufficient excuse for the appearance of his book. However, as it is considerably less in price than the treatises of Donkin and Robinson, and is on the whole more elementary, it will probably find numerous readers. The first chapters of the book are devoted to the theory of internal combustion motors, and we fear that the student who attempts to gain a knowledge of this subject from them will be sadly befogged. The author's explanations are obscure. He frequently uses technical terms without defining them, and his discussion contains so many errors that it is practically worthless for either the ordinary reader or the technical student.

On page 11 he gives the following formula for determining the pressure of a gas which has been heated at a constant volume:

$$0.002097 \times \text{acquired temperature} \times \text{initial pressure} = \text{the gage pressure.}$$

Solving the following problem: Required the pressure of a constant volume of air heated from 60° to 2,000° F., the original pressure being 14.7 lbs. per sq. in., or that of the ordinary atmosphere, he gives:

$$0.00297 \times 1940 \times 14.7 = 57.88 \text{ lbs.}$$

Both the formula and the example are wrong, and the author, strange to say, does not discover the error even when he computes the same example lower down on the page by a different formula and obtains a correct result, namely, 54.77 lbs. gage pressure. On this page the author uses the words "absolute temperature" to mean 460.66° F., instead of following the usual custom of scientific writers, which makes them mean the temperature of any given substance in Fahrenheit degrees + 460.66°.

A part of the book which we can refer to in a different tone is that in which various accessories to gas engines are described, such as igniters, exploders, governors, and the care and management of engines. Here, while the treatment is brief, it appears to be fairly good.

More than half the book is taken up with descriptions of various types of engines and motors. Most of this information is apparently taken direct from the catalogues of the different makers, but it is of course a convenience to have it all brought together in one place.

One point in this part of the book deserves criticism, which should very likely be directed at the publisher more than the author. The address of the makers of the different types of engines described are studiously omitted in every case. If it was worth while to publish this part of the work at all, it was certainly worth while to give the reader information which would enable him to supplement the facts given in the books by his own inquiries. Perhaps the publishers planned to compel gas engine builders to take advertising space in the back of the book by omitting their addresses in the body thereof. If so, their scheme did not work very well, as only ten small advertisements of gas engines appear.

HISTORY OF THE BALDWIN LOCOMOTIVE WORKS FROM 1831 TO 1897.—8vo.; cloth; pp. 86; illustrated.

This is an exceedingly interesting history of what is probably the largest industrial establishment in this country, which is still carried on as a partnership and not as a stock corporation. Its origin dates from the very beginning of steam railways in the United States, when Matthias W. Baldwin, in 1831, built a miniature working locomotive for exhibition in Peale's Museum in Philadelphia. The success of this model brought an order for a full size working locomotive from the Philadelphia, Germantown & Norristown R. R. Co., and few can now appreciate the difficulties under which this engine was built. The "Old Ironsides," as it was christened, was finally completed, however, and was tried on the road on Nov. 23, 1832, and did duty for over twenty years thereafter. Other orders followed, and the history and illustrations of the successive locomotives turned out of this establishment record the progress of locomotive design and construction in the United States up to the present time. Not only the locomotives but the tools to make them with had to be devised and built; defects in original designs had to be remedied, and new devices invented to meet new requirements brought out by the development of steam railway service. By 1834 Mr. Baldwin had completed five locomotives, and the new business was fairly well established. In this year the works were moved to Broad and Hamilton streets, the site, in part, of the present works. The various inventions and improvements devised by Mr. Baldwin are described in detail in this work and form a most valuable chapter in the history of locomotive engineering. In 1840 Mr. Baldwin built an engine for Austria, the forerunner of many others since sent to all parts of the world from the establishment which he founded. Interesting as it is, space forbids entering into the detail of the production of this establishment and the succession of advances made in design. Some idea of the progress from small to great things may be gleaned from the fact that in 1861 there had been 1,000 locomotives built at the Baldwin works; the 5,000th locomotive was turned out in 1880; the 10,000th in 1889, and the 15,000th in 1896. In 1890 almost as many engines were built as in the first 30 years of the existence of these works, which now have a capacity of 1,000 engines per year, or 3⅓ per working day, and employ a force of 5,000 men scattered through 24 separate buildings located upon 9 acres of ground.

We stated above that this was probably the largest industrial establishment still unincorporated and conducted as a partnership concern. It is interesting, in this connection, to trace out the successive partners. The founder, Matthias W. Baldwin, associated himself on April 8, 1839, with Messrs. Vail & Hufty, and the firm was known as Baldwin, Vail & Hufty, until 1841, when Mr. Hufty withdrew and left the firm of Baldwin & Vail, which continued until 1842. In this latter year Mr. Vail withdrew and Mr. Asa Whitney took his place, and the firm title was Baldwin & Whitney until 1846, when the latter retired from the firm and engaged in the manufacture of car wheels, establishing the firm of A. Whitney & Sons. In 1851, Mr. Matthew Baird, who had been connected with the works since 1836 as one of its foremen, was taken into partnership with Mr. Baldwin, and the style of the firm became M. W. Baldwin & Co. On Sept. 7, 1866, Matthias W. Baldwin died, after a life of unusual activity, during which he had contributed much, by his own mechanical skill and inventive genius, to the development of the American locomotive. Upon the death of Mr. Baldwin the business was reorganized, in 1867, under the title of The Baldwin Locomotive Works, M. Baird & Co., proprietors, and Messrs. George Burnham and Charles T. Parry, who had been connected with the works from an early period, were associated with Mr. Baird in the co-partnership. In 1870, Messrs. Edward H. Williams, William P. Henszey and Edward Longstreth were added to this firm. In 1875, Mr. Baird retired from business, having sold his interest to his five partners; and he died on May 19, 1877. A new firm was then organized on Jan. 1, 1873, under the style of Burnham, Parry, Williams & Co., and Mr. John H. Converse, who had been connected with the business department of the works since 1870, became a partner. In 1885 Mr. Longstreth withdrew and a new partnership was formed, adding Messrs. William C. Stroud, William H. Morrow, and William L. Austin. Mr. Charles T. Parry died in 1887; Mr. William H. Morrow in 1888, Mr. William C. Stroud in 1891. On Jan. 1, 1896, Samuel M. Vauclain, Alba B. Johnson and George Burnham, Jr., were admitted to partnership, making the firm at that date consist of Messrs. George Burnham, Sr., Edward H. Williams, William P. Henzey, John H. Converse, William L. Austin, Samuel M. Vauclain, Alba B. Johnson and George Burnham, Jr. With the single exception of Dr. Williams, we believe each of the successive partners in this firm since the death of its founder has been connected with it in some important capacity for a longer or shorter time before being admitted to partnership; and in only one case, that of Mr. George Burnham, Jr., has the son of a partner become a member of the firm. It has evidently been the policy of this firm from the beginning to commit the conduct of its affairs only to men who had been trained in the methods of the establishment and whose ability had been proved by the work they had accomplished. This policy, without doubt, is one important factor in the long-continued success of this great industrial establishment.

The history of the mechanical development of the locomotive which is contained in this book we cannot attempt even to abstract here, but it is so interesting and valuable a record that the book should be included in the library of every engineering school and engineering society. We are informed that the Baldwin Works will furnish copies to such institutions on request.